VOLUME 60 NUMBER 2

THE BRYOLOGIST

•JOURNAL OF THE•
AMERICAN BRYOLOGICAL SOCIETY

EDITOR
HOWARD A. CRUM

ASSOCIATE EDITORS
MARGARET FULFORD LEWIS E. ANDERSON
WILLIAM C. STEERE WILLIAM L. CULBERSON

JUNE, 1957

CONTENTS

The Ephemeraceae in North America
Virginia S. Bryan and Lewis E. Anderson 67

Cytotaxonomic studies in the Ephemeraceae and Funariaceae
Virginia S. Bryan 103

Taxonomic notes. XIII. The genus Campylium
A. LeRoy Andrews 127

The sporophyte of Mnium hymenophyllum
Kjeld Holmen 135

Mosses from the United States Antarctic Service Expedition, 1940-41
Edwin B. Bartram 139

Tortula papillosa in New Mexico
William A. Weber 143

Notes on nearctic Hepaticae. XII. Marsupella paroica n. sp.
Rudolf M. Schuster 145

Frullania haematocysta
Lois Clark 151

Jamaica lichens. Some unreported collections
W. L. Dix 154

Reviews 166

Recent literature 167

News and Notes 175

PUBLISHED QUARTERLY BY THE AMERICAN BRYOLOGICAL SOCIETY

THE BRYOLOGIST.—A quarterly journal devoted to the study of North American mosses, hepatics, and lichens, published by the American Bryological Society. **Subscription price, in the United States, $5.00 per year, net; in all other countries, $5.15. Single copies, $1.50. Comprehensive Index to volumes 1-10, $1.00.**

Back volumes of THE BRYOLOGIST are available from Dr. Lewis E. Anderson, Department of Botany, Duke University, Durham, N. C.; or the Secretary-Treasurer, at the following prices: volumes 1-4, $1.25 each; volumes 5-36, $2.50 each (60 cents per individual number); volume 37, $3.00; volumes 38-45, $3.50 each (85 cents per individual number); volumes 46-49, $4.00 each; volume 50, $8.00; volumes 51-56, $5.00 each ($1.50 per individual number).

PUBLICATION OFFICE: Seeman Printery, Durham, N. C.

Address manuscript to the Editor:

DR. HOWARD A. CRUM, National Museum of Canada, Ottawa, Ontario, Canada.

Manuscripts should be typewritten, double-spaced, on 8½ by 11 inch sheets. Only first copies (not carbons) should be submitted. Reprints of articles will be supplied at a reasonable price if ordered when corrected galley proof is returned.

Address subscriptions, applications for membership, and advertisements either to the office of publication or to the Secretary-Treasurer, DR. L. J. GIER, Department of Biology, William Jewell College, Liberty, Missouri.

Address all specimens for identification directly to the Curator concerned.

Entered as second-class matter at the Post Office at Durham, N. C.

OFFICERS OF THE AMERICAN BRYOLOGICAL SOCIETY

President.....RUTH SCHORNHERST BREEN
Florida State University, Tallahassee

Vice-President.....JOHN W. THOMSON
University of Wisconsin, Madison

Secretary-Treasurer.....L. J. GIER
William Jewell College, Liberty, Mo.

Editor.....HOWARD A. CRUM
National Museum of Canada, Ottawa

Associate Editors
MARGARET FULFORD, W. C. STEERE, L. E. ANDERSON, W. L. CULBERSON

Curator of the Moss Herbarium.....LEWIS E. ANDERSON
Duke University, Durham, N. C.

Curator of the Hepatic Herbarium.....MARGARET FULFORD
University of Cincinnati, Cincinnati, O.

Curator of the Lichen Herbarium.....WM. A. WEBER
University of Colorado, Boulder

Director of the Moss Exchange.....E. H. KETCHLEDGE
State College of Forestry, Syracuse, N. Y.

Director of the Hepatic Exchange.....LEO F. KOCH
University of Illinois, Urbana

AIBS Representative.....ELBERT L. LITTLE, JR.
U. S. Forest Service, Washington, D. C.

AAAS Representative.....AARON J. SHARP
University of Tennessee, Knoxville

THE BRYOLOGIST

JOURNAL OF

THE AMERICAN BRYOLOGICAL SOCIETY

VOLUME 60 JUNE, 1957 NUMBER 2

THE EPHEMERACEAE IN NORTH AMERICA[1]

VIRGINIA S. BRYAN and LEWIS E. ANDERSON[2]

In the past North American bryologists included in treatments of the Musci, for the most part, only brief descriptions of members of the Ephemeraceae. Almost nothing has been known of the relationships or variability of this widespread and sizable family.

Sullivant (1856) first listed the North American Ephemeraceae. As a part of the genus *Phascum* he included four species in the section Ephemerum. Rau and Hervey (1880) mentioned seven species of *Ephemerum* in the family Physcomitrellae. Shortly thereafter, Lesquereux and James (1884) published in the *Manual of the Mosses of North America* a compilation of brief descriptions of 10 ephemeraceous species. Three species of *Nanomitrium* and eight of *Ephemerum* appeared in Renauld and Cardot's list (1892-93). Barnes and Heald (1896) included seven species of *Ephemerum* and three species of *Nanomitrium* (as *Micromitrium*) for North America, while Kindberg (1897) recognized nine *Ephemera*, three *Nanomitria* and two *Ephemeridia* (*Ephemerum* species) in the family Bruchiaceae. In the early part of this century Jennings (1913) attributed nine species of *Ephemerum* to western Pennsylvania. Most recent and most complete taxonomically, Grout's *Moss Flora of North America* (1933-40) lists six species and five varieties of *Ephemerum*, as well as two species and one variety of *Nanomitrium*. His commentary on each species, though brief, is provocative because it emphasizes the confusion within the family.

Our study of the family has been directed along three lines of

[1] Grateful acknowledgment is made to the National Science Foundation for partial support of this investigation by a grant of research funds (NSF G23222) to Duke University.

[2] Dept. of Botany, Duke University, Durham, N. C.

approach: (1) critical study of a large number of specimens from some of the principal herbaria of North America; (2) field studies carried on intensively for the past four years, and by the junior author for several years preceding; and (3) chromosome studies made by the senior author (Bryan, 1957). We have examined specimens from the following herbaria: National Museum of Canada (CAN), Florida State University (FSU), University of Michigan (MICH), New York Botanical Garden (NY), Stanford University (DS) and University of Tennessee (TENN). We are grateful to the curators for the loan of the specimens, and to W. C. Steere, R. M. Schuster, Alfred Clebsch and W. B. Schofield for making available certain special collections. Our studies centered on the many specimens in the Duke University collections (DUKE): the American Bryological Society Herbarium, the Duke University Herbarium and the Grout Slide Collection.

Although most of our conclusions are based on comparative morphology, and to some extent cytology, undoubtedly we have been influenced also by our field experience. We have made over 50 collections and have examined living material of all of the taxa known from North America. Field activities were confined to eastern North America, including southern and northern Florida, Mississippi, Georgia, the North Carolina Coastal Plain, Piedmont and Mountains and Michigan.

The Ephemeraceae are the smallest and most delicate of the mosses. North American species range from 0.7 to 2.8 mm. high, and the individual plants are solitary, or gregarious, or scattered in an abundant, tufted protonema. Minute antheridial plants may occur at the base of the stem of archegonial plants, or nearby on the same protonema. Also, both autoicous and synoicous conditions have been seen in the family. The archegonial plants consist of rarely more than 10 narrow leaves surrounding a sessile, indehiscent, or at least functionally indehiscent capsule. The columella almost never persists to maturation so that ripe capsules contain only spores, or in some species spores and a spore sac.

Ephemerum and *Nanomitrium* occupy bare soil, especially alluvium, on swamp floors, old fields, lawns, revegetating paths, ditch banks and stream banks. Not infrequently they occur on decaying wood, most often in wet habitats. The habitats represent, for the most part, areas disturbed by man's activities and are more or less weedy situations. Nevertheless, with a few exceptions, the pioneer bryophytes on these bare areas are not weedy and ubiquitous species. Most have restricted ranges, and many are rare and uncommon. *Funaria hygrometrica, Weissia controversa, Ceratodon purpureus* and several species of *Bryum* are widespread weeds

found in these habitats, but most moss pioneers are less common genera, such as *Discelium, Archidium, Bruchia, Pleuridium, Acaulon, Astomum, Physcomitrium, Physcomitrella, Aphanorhegma* and *Entosthodon,* to mention only a few. Among hepatics the non-weedy genera *Sphaerocarpus, Riccia, Anthoceros, Asterella, Fossombronia,* etc. occupy revegetating areas.

The Ephemeraceae are commonly found in wet sites but are not as dependent on periodic flooding and a high water table as has been emphasized in the literature (Nichols, 1910a, b; Beals, 1924; Gray, 1932). In the southeastern United States, *e.g., Ephemera* occur in greatest abundance in old fields in both upland and flood plain sites, varying in age of abandonment from less than one to five years. Human activities have thus opened up huge new areas favorable for occupancy by Ephemeraceae and associated species. Species which previously may have enjoyed at least some measure of edaphic isolation are now competing for the same habitats and can be found growing in close proximity, even intermingled. The extent to which *Ephemera* hybridize is not known, but since all the species share the same habitats, only genetic barriers, if any, separate the species of eastern North America.

The persistent protonemata of these mosses emphasize the limitations of the term dioicous. Together with polyoicous, monoicous, synoicous, paroicous and autoicous, this term was proposed prior to the discoveries of genetic influences on sexual differentiation and it describes only the relative positions of the antheridia and archegonia. No genetic potentialities are implied by the term. In monoicous mosses the genetic situation can be inferred, but not in dioicous mosses for at least two sexual conditions are possible: (1) a single protonema may produce only leafy plants of one sex, either archegonial or antheridial; (2) both archegonial and antheridial plants may arise from a single protonema, *i.e.,* from a single spore; actually, this is only a step removed from the autoicous condition. Thus, a knowledge of the protonematal origin of antheridial and archegonial plants is necessary in order to determine which condition exists. In *Ephemerum* with its persistent protonema we have found antheridial branches attached to the base of the archegonial plant and have also found antheridial plants separated from the archegonial plant but on the same protonema. Therefore, these species bear potentialities for both sexes. This distribution of antheridial and archegonial plants on one protonema cannot be detected, of course, in mature colonies of species without persistent protonemata.

KEY TO THE EPHEMERACEAE

Calyptra more than 0.2 mm. in over-all length, companulate, torn at the base; leaves costate or virtually ecostate, when dry scarcely contorted or shriveled; capsules ovoid, apiculate and cleistocarpous; polyoicous, antheridia in buds at the base of archegonial plants or in separate antheridial plants but apparently always on the same protonema as archegonial plants; haploid chromosome number 27.....*Ephemerum*

Calyptra minute, consisting of scarcely more than the old archegonium, less than 0.2 mm. in length; leaves virtually ecostate, shriveled and somewhat contorted when dry; capsules globose,. scarcely apiculate, some opening at a line of dehiscence near the middle; polyoicous or synoicous, antheridia and archegonia mixed in the same cluster; haploid chromosome number 11 or 22 .....*Nanomitrium*

EPHEMERUM Hampe, Flora 20: 285. 1837.

Phascum Hedw., Sp. Musc. 19. 1801 (in part).
Ephemerella C. M., Syn. Musc. 1:34. 1848.
Ephemeridium Kindb., Rev. Bryol. 22: 23. 1895.

Ephemerum was established by Hampe in 1837 to include three species, *E. crassinervium*, *E. serratum* and *E. cohaerens*, found in Europe and North America. *Ephemerum serratum* had been treated by Schreber in *De Phasco Observationes* (1770) and, together with *E. cohaerens*, appeared in Hedwig's *Species Muscorum* (1801) under *Phascum*. *Phascum crassinervium* was described by Schwaegrichen in 1811 and transferred by Hampe (1837) to *Ephemerum*. Sullivant (1856) included a variety of *E. crassinervium*, later described by Schimper (1860) as *E. spinulosum*. *Ephemerum wrightii*, a Cuban species described by Müller (1881?) we consider to be in *Nanomitrium*. We are placing in synonymy *E. flotovii* Funck *ex* Brid. (a synonym of *E. cohaerens*), *E. pallidum* Schimp. (synonym of *E. crassinervium*), *E. minutissimum* Lindb. (synonym of *E. serratum*), *E. hystrix* Lindb. (synonym of *E. spinulosum*).

By far the most abundant species of *Ephemerum* in North America are *E. crassinervium* (Schwaegr.) Hampe and *E. spinulosum* Schimp. Both species are plastic, and even the diagnostic characters, shape, serrations and areolation of the largest leaves, are variable. In typical form the two species are quite distinctive and easily recognized, and the vast majority of specimens can be named with confidence. The puzzling intermediates, however, share characters of both species. One of the main problems of this investigation has been to evaluate the relative worth of the numerous characters used in attempts to fix the limits of these species. Most subspecific taxa segregated from these species, e.g., *E. crassinervium* var. *papillosum* (Aust.) Ren. & Card., *E. spinulosum* var.

hystrix (Lindb.) Grout and *E. spinulosum* var. *texanum* Grout, are manifestations mostly of single variable characters, which, when strongly expressed appear to be completely distinct from typical *E. crassinervium* or *E. spinulosum;* when weakly expressed, on the other hand, the characters are unreliable, and the boundaries of the taxa become somewhat arbitrary.

On the basis of herbarium specimens and in the light of our field experiences *E. crassinervium* appears to be more abundant toward the north, while *E. spinulosum* is more common in the southern states. We have seen only a few specimens of *E. crassinervium* from Florida, and they are not typical of the species. Varying in the direction of *E. spinulosum,* their largest leaves resemble figures 11 and 17 but have somewhat laxer areolation. South of North Carolina and Tennessee, *E. crassinervium* becomes less frequent, as *E. spinulosum* becomes the common *Ephemerum.*

1. Upper leaves virtually ecostate.....*E. serratum*
1. Upper leaves costate, at least in upper half..... 2
2. Cells in the middle third of leaf lamina smooth, in diagonal rows from costa to margin.....*E. cohaerens*
2. Cells of the leaf lamina papillose above, usually conspicuously so; or if smooth, not in diagonal rows..... 3
3. Upper leaves with spines mostly recurved at an angle of 45° or more; leaves usually narrowly linear-lanceolate; lamina papillose or smooth above; leaf cells at middle of leaf about 4-8 : 1.....*E. spinulosum*
3. Upper leaves almost entire to strongly toothed; most of the teeth extending at an angle less than 45°; lamina conspicuously papillose above; leaf cells at middle of leaf usually less than 4 : 1 4
4. Upper leaves lanceolate; without shoulder.....*E. crassinervium*
4. Upper leaves broadly lanceolate-subulate with slight to prominent shoulder.....*E. crassinervium* var. *texanum*

1. EPHEMERUM CRASSINERVIUM (Schwaegr.) Hampe, Flora 20: 285. 1837. *Phascum crassinervium* Schwaegr., Suppl. Sp. Musc. 1: 4. 1811. *Ephemerum pallidum* Schimp., Syn. Musc. Eur. 5. 1860. *Phascum crassinervium* var. *stenophyllum* Hook. & Wils. *in* Drumm., Musci Amer. S. States 3. 1841 (in part). *Ephemerum crassinervium* var. *papillosum* Ren. & Card., Musci Amer. Sept. Exs. 266. *Ephemerum papillosum* Aust., Musci Appal. 50. 1870.

In typical *E. crassinervium* the leafy archegonial plants are uncrowded in a sparse protonema. The largest leaves are costate and papillose. The shape, areolation, and serration of these largest leaves are the most reliable characters for distinguishing the species (*fig.* 54). Long-lanceolate and slenderly acuminate, they measure usually about 1.5 mm. (from 0.8-2.5 mm.) long and

0.2 mm. (0.19-0.36 mm.) wide near the base. The areolation varies from base to apex. The lower cells are relatively large, mostly quadrangular, 15-30 μ wide and 2-3 times as long. They are progressively smaller toward the apex, and in the acumen are 6-12 μ wide and 4-6 times as long. In the lowest third of the upper leaves the margins are mostly entire, above barely toothed to strongly toothed. In calyptra characters there is no obvious difference between *E. crassinervium* and *E. spinulosum*. Calyptras of *Ephemerum crassinervium* range from 0.25 to 0.35 mm. in over-all length. Some are slightly mammillose, others slightly or strongly papillose. Similarly, sporophytic characters are of little help in separating the species. The ovoid capsule, up to 0.5 mm. high, with a short, usually inclined apiculus characterizes both species. In *E. crassinervium* the stomata are few and scattered throughout the exothecium. Maturing from early fall to early spring, the orange-brown, reniform spores exhibit a wide range of markings and range from 35 × 50 μ to 75 × 95 μ.

Of the more than 100 specimens of this species we have studied one of the more typical is Renauld and Cardot's *Musci Americae Septentrionalis Exsiccati* 266. It was collected in Athens, Illinois, and issued as *E. crassinervium* var. "*papillosum*," as an unpublished transfer of *E. papillosum* Aust. The plants embody the distinguishing characters of the species. The long-lanceolate upper leaves reach 1.5 mm. in length and 0.2 mm. in maximum width; the margins are serrate in the upper two-thirds, and the areolation is dense in the upper half; a strong costa occupies the acumen and extends to the base. Figure 16 is from a North Carolina specimen but resembles closely the plants in Renauld and Cardot's no. 266. It represents our concept of a typical leaf of *E. crassinervium*. Lower leaves are always more shortly acuminate and even the upper leaves of some plants have a shorter acumination, as illustrated by figures 12 and 15. James' specimen from Pennsylvania, collected in 1871, also is good *E. crassinervium*, although the plants tend to be somewhat shorter than average. Grout (1935) considered Austin's *Musci Appalachiani* 50 to be *E. crassinervium* var. *papillosum*, but in sets at Duke and the New York Botanical Gardens this number contains good *E. crassinervium*. The truly lanceolate leaves are barely papillose below the awn, and, as Grout observed, the calyptra is papillose. Both specimens, however, contain admixtures of *E. spinulosum* var. *texanum*, which will be discussed later. Austin's *Musci Appalachiani* 48 from New Jersey also represents nearly typical *E. crassinervium*. A leaf from this collection is shown in figure 19. Frequently, this species grows mixed with E. *spinulosum*. Nearly all the exsiccati we have ex-

amined contain mixtures, and some of the confusion among species is undoubtedly due to this fact. *Ephemerum crassinervium* var. *papillosum* was described on the basis of a strongly papillose calyptra and narrower leaves, but we have found in North American specimens no correlation between width of leaf and papillosity of calyptra. In fact, we believe that the cells of the calyptras in this complex range from smooth or slightly bulging or mammillose to strongly bulging or papillose, without correlation with any other character. Certainly width of leaves varies independently of papillosity of calyptras. We are of the opinion, therefore, that var. *papillosum* is not worthy of recognition and we are including it as a synonym of *E. crassinervium*.

1a. **Ephemerum crassinervium** var. **texanum** (Grout) n. comb. *Ephemerum spinulosum* var. *texanum* Grout, Moss Fl. N. Amer. 2(2) : 70. 1935.

Grout described *E. spinulosum* var. *texanum* from his *North American Musci Perfecti* 275. The collection was made at Bastrop, Texas, by McAllister. Grout also (1935) cited a collection from the Santee Canal in South Carolina (*Ravenel* 196). We have examined these specimens, and find them to be, without doubt, worthy of varietal rank. However, their closest affinities unquestionably lie with *E. crassinervium*, and we are accordingly making the transfer.

Displaying similarities to both *E. crassinervium* and *E. cohaerens*, the largest leaves of these specimens are broadly lanceolate to oblong-lanceolate. They are mostly 1.1 mm. long and 0.25 mm. at the maximum width, although larger and smaller leaves are found. The costa, differing little from *E. crassinervium* and *E. spinulosum*, is, as Grout described it, thin or vanishing at the base and stronger and often excurrent at the apex. The largest leaves are broadly acuminate, serrate and usually densely papillose (*fig.* 55). We find that the most outstanding characteristic, however, is the tendency for the upper leaves to have narrow or broad shoulders deeply incised or spiny-toothed. Figures 21, 25 and 27 illustrate extremes of this feature. In this trait the variety resembles *E. cohaerens*, but the shoulders are not usually as pronounced (*cf. fig.* 29, 33, 35). Probably Grout considered var. *texanum* a part of *E. spinulosum* because of the spines sometimes occurring on the shoulders. Figure 21, a leaf of var. *texanum* from Connecticut, has the closest resemblance to *E. spinulosum* that we have observed. Its nearest relationship is to *E. crassinervium* as shown by the merely toothed acumen, the compact areolation and papillosity in the upper two-thirds of the acumen. Regardless of the exceptional specimens with areolation matching that of *E. crassinervium*,

the variety seems to have a somewhat more compact cell network. The upper cells are oblong to hexagonal, about 8 μ wide and 2-3 times as long; the smooth basal cells are 10-20 μ wide and 3-5 times as long.

Most of the capsules are subglobose and bluntly apiculate. The capsule characters are variable, however, and occasionally, a sharply apiculate exothecium is found. The seta, in some specimens barely discernible, in other specimens may exceed the length found in *E. crassinervium*, *E. spinulosum* or *E. cohaerens*. Few stomata are found and they are scattered throughout the capsule wall. As in the species, the calyptra and spore characters vary widely. Although figure 27 is of a leaf from the type specimen, we do not regard it as typical of var. *texanum*, but rather as a broader variation. The majority of specimens encountered have narrower leaves and less exaggerated shoulders, conforming more nearly to those illustrated in figures 20, 23 and 24.

2. E. SPINULOSUM Schimp., Syn. Musc. Eur. 6. 1860. *Phascum crassinervium* var.?, Sull., Musc. and Hep. U. S. 14. 1856. *Phascum serratum* var. *angustifolium* Hook & Wils. *in* Drumm., Musci Amer. S. U. S. 2. 1841 (in part). *Ephemerum hystrix* Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 13: 411. 1874. *Ephemerum spinulosum* var. *hystrix* (Lindb.) Grout, Moss Fl. N. Amer. 2(2): 70. 1935.

In the Ephemeraceae there are few characters by which species can be distinguished at low power magnification. But with some degree of certainty one can distinguish typical material of *E. crassinervium* and *E. spinulosum* with a hand-lens. *Ephemerum spinulosum* grows from an unusually abundant and persistent, almost felt-like protonema, while *E. crassinervium* only rarely displays such rich protonematal growth at the time the leafy plants are reaching maturity. The spines, when well-developed, in *E. spinulosum* can also be detected with a hand-lens.

The characteristics of *E. spinulosum* as seen in the type material, Drummond's *Musci Americani Southern States* 2 (*fig.* 9) (NY, DUKE), happen also to be the aggregation most commonly found in this variable species. The largest leaves are narrowly lanceolate or linear, the narrowest of the genus (*fig.* 53). They are about 1.3 mm. (from 1-2 mm.) long and 150 μ (from 100 μ and rarely up to 260 μ) wide. The leaf margins in *E. spinulosum* are occasionally only short-toothed (*fig.* 5), but by far the most specimens show relatively long, pointed or rounded spines (*fig.* 1, 3, 8). The spines are made up of projecting marginal cells. Usually, one cell projects almost all of its length to produce the spine, but not infrequently the spines are composed of two cells,

the terminal one acute (*fig. 7, 9*). Most spines measure 40-50 μ and recurve 45° or more. Below the middle of the largest leaves the cells are almost or as large as in *E. crassinervium*, but the diminution in cell sizes upward is not as pronounced. Thus, above the middle of the largest leaves the cells are larger than in *E. crassinervium* and they lend a more hyaline appearance to the leaves. A further difference in areolation of the two species lies in the cell walls. In general, the cells of *E. crassinervium* leaves, especially in the lowest third, have a somewhat flaccid form giving at least the appearance of thinner walls. Most specimens of *E. spinulosum* have leaves whose cells appear rigid. Possibly they have thicker walls.

We find no distinguishing features in the calyptras, despite the fact that early workers devoted much study to this structure and placed considerable taxonomic emphasis upon it. Many herbarium specimens of *E. crassinervium* and *E. spinulosum* are accompanied by drawings and notes on the shape, lobation and degree of bulging of the cells. Yet, our studies have shown that calyptras on plants bearing typical *E. spinulosum* leaves vary from smooth to papillose and are indistinguishable from the calyptras of *E. crassinervium*. The over-all length of the calyptra in the type specimen of *E. spinulosum* is 0.39 mm., and the cells are papillose with sharply bulging papillae at the cell ends.

Sporophytic characteristics are of little value in identifying the members of the *crassinervium-spinulosum* complex. One possible exception is the distribution of stomata in the exothecium. In *E. spinulosum* they are usually found at the equator or below, while in *E. crassinervium* they seem to be fewer and occasionally are found above the equatorial region. Besides the diversity of spore markings caused by different degrees of maturity, a diversity of markings of the mature spores ranges from finely papillose to coarsely warty. The spores are red-brown, shortly-reniform and about 50 × 70 μ.

Specimens of Holzinger's *Musci Acrocarpi Boreali-Americani* 351 (*fig. 2*) (CAN, DUKE, NY) from Sanford, Florida, approach the type material in spines and costa, but the upper leaves tend to be somewhat wider. The spines are often double-pointed, and most recurve from 45-90°. The calyptras in most of these plants are non-papillose. An outstanding feature of the Holzinger specimens is the presence of very large spores, the largest we have encountered in the family. Spores about 70 × 100 μ are not uncommon, and we have found some 110 μ. These large spores are finely papillose.

Northern collections of *E. spinulosum* do not differ from the

southern material. Macoun's *Canadian Musci* 465, from Ottawa, Ontario, and Holzinger's *Musci Acrocarpi Boreali-Americani* 126 (*fig.* 10) from Winona, Minnesota, contain reasonably good examples of *E. spinulosum*. Although Grout (1935) considered the Holzinger specimen to be intermediate between *E. spinulosum* and *E. crassinervium*, our material (DUKE, NY), although scanty, was clearly *E. spinulosum*, with somewhat shorter spines than usual. Both the Holzinger and the Macoun numbers contain *E. crassinervium* also.

Despite the clear-cut distinction between *E. spinulosum* and *E. serratum* based on the absence of a costa in all leaves of the former, many specimens of *E. spinulosum* have been labelled *E. serratum*. Because of these errors, we should emphasize that the largest (usually the uppermost) leaves bear the distinguishing traits. The lower leaves and perigonial leaves of all the species are likely to be smaller, ecostate and only serrulate to serrate. They do bear some resemblance to *E. serratum*. Figure 4 shows a leaf of *E. spinulosum* varying in this direction.

Ephemerum spinulosum var. *hystrix* (Lindb.) Grout was segregated on the basis of a costa lacking in some leaves and in only the upper half of others (*fig.* 4). Our studies have shown that the extent of costal development varies widely from plant to plant and from leaf to leaf on individual plants. In the *crassinervium-spinulosum* complex the upper leaves have the strongest costal development. They may have a central column two cells thick and about four cells wide from the base to the apex, where it is narrower (*fig.* 2), or it may be in the upper two-thirds only (*fig.* 6). The middle leaves are usually not costate to the base, and the lowest leaves are usually ecostate. Among the specimens we have studied, we could find none in which weak costal development correlates with another character, and so we believe that the weakly costate specimens must be included in the species *E. spinulosum*. A comparison of the group of *E. spinulosum* leaves featured in figures 1-10 shows the variable nature of costal development at the leaf base.

3. EPHEMERUM COHAERENS (Hedw.) Hampe, Flora 20: 285. 1837. *Phascum cohaerens* Hedw., Sp. Musc. 25. 1801. *Phascum flotowii* Funck *ex* Brid., Bryol. Univ. 1: 754. 1826. *Ephemerum cohaerens* var. *flotowianum* (Funck *in lit*) Hampe, Flora 20: 285. 1837. *Ephemerella flotowianum* (Hampe) Schimp. Syn. Musc. Eur. 8. 1860. *Ephemerum flotowianum* (Hampe) Limpr., Laubm. Deutschl. 1: 168. 1885.

Typically one of the most distinctive species in the genus, *E. cohaerens*, like most of its congeners, is variable. It is charac-

terized by broad, oblong-lanceolate upper leaves, usually rather abruptly narrowed to a sharply pointed acumen. The abrupt narrowing is responsible in typical material for distinct shoulders which are unevenly and irregularly serrate to spinose, often appearing laciniate (*fig.* 56). The shoulders are characteristically asymmetric, one more deeply incised and less regularly spinose or dentate than the other. The percurrent or excurrent costa is rather broad, but effaced at the base, and becomes stronger and thicker toward the apex. The basal leaf cells are large, thin-walled, hyaline and elongate-hexagonal and they become in the middle third of the leaf progressively more quadrate to rectangular, occasionally elongate-hexagonal and thick-walled. The diagonal arrangement of the cells in the middle third of the largest leaves is unique in this species and almost invariable. The leaf cells are usually smooth, except for the back of the costa, which is toothed. Most calyptras are smooth and fugacious. Only one sporophytic character is diagnostically helpful; the stomata are distributed over the entire surface of the capsule. The reniform spores, papillose to coarsely and irregularly tuberculate or warty, vary between 60 μ and 95 μ. A feature we have not observed in other species of *Ephemerum* is the occasional persistence of the columella until the spores are mature. Only rarely have we seen the columella in completely mature capsules, although we have seen it more often at the time of meiosis. *E. cohaerens* has been described by previous workers as dioicous, but we have observed antheridial branches attached to the base of archegonial plants and adjacent on the same protonematal branch. Probably it is best described as polyoicous (autoicous and dioicous).

Alfred Clebsch has collected a remarkable form of *E. cohaerens* near Clarksville, Montgomery Co., Tennessee (no. 840, Oct. 21, 1947, TENN). Two leaves are pictured in figures 34 and 35. The plants are very robust, with exceedingly broad leaves, broadest above the middle. The largest leaves are almost spatulate and are abruptly narrowed to a long acumen, conspicuously recurved. The leaves are strongly keeled and overlap in a way that causes the plants to appear somewhat triquetrous, resembling to a certain extent species of *Acaulon*. The leaf cells are large and lax, tending to be long-rectangular, rather than hexagonal. Nevertheless, the upper cells extend diagonally from the costa as in typical *E. cohaerens*. Early in the present study we were convinced that the Clebsch collection represented an undescribed entity, but we have since seen specimens intermediate between these plants and typical *E. cohaerens*. Additional collections by Clebsch in the vicinity of Clarksville, show a tendency to vary in the direction of no. 840

but are by no means as extreme. Bryan no. 494 from southern Florida has unusually flaccid leaves with lax areolation. Also several collections made by Pennebaker in January and February 1939 in the vicinity of New Orleans, Louisiana (TENN), and Sullivant and Lesquereux's *Musci Boreali Americani* 23 (NY) have the same broad carinate leaves with a long acumen, markedly recurved. They differ from the Clebsch material only in somewhat smaller stature and smaller leaf cells. Therefore, we are inclined to regard the Clebsch specimen only as an extreme, broad-leaved, lax form of *E. cohaerens*. We have encountered many difficult forms of *E. cohaerens*, as well as of other *Ephemera*, and it is significant to note that variations are also found in European material of *E. cohaerens*. The illustrations, for example, of the species in the *Bryologia Europaea* (fasc. 42, pl. 1) were made from a narrow-leaved form in which the shoulder of the leaf is obscure, and even narrower-leaved forms are known to occur.

Various authors have from time to time recognized var. *flotowianum* (Funck) Hampe, of *E. cohaerens*, as a good subspecific entity. It was erected to include plants with long-lanceolate leaves, serrate from the middle upward, excurrent costae and dark red-brown capsules with large warty spores. These are characters, however, of degree only and cannot be correlated in any way. Plants with narrowly lanceolate leaves may be found with margins weakly to strongly serrate and with weak to strong costae. The capsule and spore characters are totally unreliable. In practice, bryologists have rather arbitrarily referred all plants with excurrent costae to var. *flotowianum*, so that the variety has become only a convenient pigeon-hole. In our opinion it is not even a weak entity, and we have no hesitation in dropping it.

We have seen specimens of *E. cohaerens* from Ontario, New Hampshire, Connecticut, Pennsylvania, Michigan, Ohio, Iowa, Tennessee, North Carolina, Georgia, Florida, Louisiana and Texas.

4. EPHEMERUM SERRATUM (Hedw.) Hampe, Flora 20: 285. 1837. *Phascum serratum* Hedw., Sp. Musc. 23. 1801. *Phascum stoloniferum* Hedw., Sp. Musc. 24. 1801. *Ephemerum minutissimum* Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 13: 411. 1874. *Ephemerum serratum* var. *minutissimum* (Lindb.) Grout, Moss Fl. N. Amer. 2(2): 68. 1935.

Characterized mainly by the absence of a well-defined costa, this species exhibits also rather lax, hexagonal-rhomboidal leaf cells and serrated leaf margins (*fig.* 57). In growth habit the plants are gregarious, coming from a dark green, persistent protonema which is rather densely matted. In this respect it resembles *E. spinulosum*, which has the thickest and most conspicu-

ous protonema of the genus. The leaf shape in *E. serratum* varies from narrowly lanceolate to ovate-lanceolate. Most commonly, the leaf apex tapers gradually to a sharp, acuminate point and usually ends in a single, elongate, sharply pointed cell. Plants are sometimes encountered, however, in which the leaves are rather abruptly narrowed to a short, broad, somewhat acute point and lack the elongated terminal cell. The leaf margin is generally coarsely and somewhat irregularly toothed with long, often recurved spines, but, again, plants may be found in which the leaf margins are only subserrate to serrate with short, sometimes even obscure teeth. All intergradations between the extremes have been observed. The capsules are reddish-brown and, according to Dixon (1924), "glossy." Stomata are confined to the base of the capsule.

The taxonomic confusion in *E. serratum* centers principally around several weakly-defined subspecific taxa. Perhaps the most puzzling of these has been the var. *angustifolium*, described in the *Bryologia Europaea* (fasc. 42, p. 1, *pl.* 1) as "folia angustiora, subsecunda lineali-lanceolate, minus grosse serrata. Capsule ovalis, minor, minus intense purpurea. Calyptra angustior." The several illustrations agree perfectly with this description, showing in addition leaves that are somewhat broadly acuminate and lacking the elongate terminal cell characteristic of the species proper. Two collections were cited in the text: "Var. β locis similibus in Sardinia (Müller) et in Britannia una cum *Astomo Mittenii* prope Hurstpierpoint (Mitten)." We have not seen Müller's Sardinian collection, but, through the courtesy of Donald P. Rogers, we have examined the collection from Hurstpierpoint, which is represented in abundance in the Mitten collection at the New York Botanical Garden. The Hurstpierpoint plants differ somewhat from the *Bryologia Europaea* illustrations, having narrowly lanceolate leaves, rather long, sharply acuminate and even flexuose. The leaf margins are more strongly toothed, with teeth that extend mostly at right angles to the margin, rather than at 45°. The marginal teeth of some leaves are spinose and even recurved. Except for the fact that they are narrower and shorter, the leaves in the Hurstpierpoint collection resemble typical *E. serratum*.

Braithwaite's drawings (1887) illustrating *E. minutissimum* Lindb. were made from Mitten's Hurstpierpoint collection (as *E. novale* Mitt. *in litt.* in the plate legend but corrected in the text, p. 184, to *E. minutissimum*) and in our opinion correctly represent that collection. We have examined the type of *E. minutissimum*, which, according to Roth (1911) is a James collection from Cambridge, Massachusetts, made in 1870. It agrees perfectly with Mitten's Hurstpierpoint plants, and Braithwaite is

correct in placing them in the same entity. Grout (1935) is therefore undoubtedly correct in inferring that the drawings in the *Bryologia Europaea* of var. *angustifolium* were made from Müller's Sardinian plants and not from the Hurstpierpoint plants. Accordingly, Grout reduced var. *angustifolium* "in part" to the synonymy of *E. minutissimum*, which he treated as *E. serratum* var. *minutissimum* (Lindb.) Grout and excluded the Sardinian collection. If either epithet were to be retained, this would be the correct disposition, as the latter name has priority by some 10 years.

In our opinion *E. minutissimum* does not deserve recognition at any level, specific or subspecific. The principal characters upon which Lindberg (1874) erected *E. minutissimum* are the small size of plants; reduced leaves, *i.e.*, shorter and narrower, but especially narrowly lanceolate-acuminate leaves, channeled, attenuated and flexuose at the points; leaf margins irregularly serrate above; leaf cells longer, narrower and less lax than in *E. serratum;* spores smooth, smaller. The spore characters do not hold, as we have found plants that otherwise fit *E. minutissimum* with spore sizes ranging from 50 μ to 80 μ, the majority falling between 60 μ and 70 μ. These measurements apply equally well to typical *E. serratum*. The roughness of the spores of *E. minutissimum*, as in all species of *Ephemerum*, is quite variable. We have not observed any mature specimens with smooth spores, as was originally described for *E. minutissimum*, but rarely we have seen plants with finely papillose spores. This condition also occurs in typical *E. serratum*, although the majority of plants of both entities have coarsely papillose spores. Thus, one is left entirely with leaf characters to separate *E. minutissimum* from *E. serratum*, namely the narrowly lanceolate, shortly acuminate leaves of the former as opposed to broadly lanceolate, long-acuminate leaves of the latter. With the narrowly lanceolate leaves usually go narrower and longer leaf cells which are less lax. The extremes of these two leaf types are rather well marked, but we find a series of intergradations between them and a total absence of correlating characters. We have no hesitation, therefore, in merging *E. minutissimum* with *E. serratum*.

The majority of the material we have seen from eastern North America varies in the direction of the *minutissimum*-like characters, *i.e.*, short, narrow leaves, longer and narrower leaf cells and short acumination, but we have seen occasional collections closely approaching well-developed *E. serratum* as it is known in much of Europe. Some of Austin's specimens from New Jersey, of which there are numerous collections in the herbarium of the New

York Botanical Garden, are quite similar to European material, as is Austin's *Musci Appalachiani* 47b.

E. serratum is not common in North America. We have seen specimens from California, Nova Scotia, Saskatchewan, Ohio, Massachusetts, New York and New Jersey only. Apparently, the species is more common, and plants are best developed toward the north. The most luxuriant plants examined are those from Nova Scotia. We have seen no specimens collected south of New Jersey. The widely distributed material from Tennessee (*Cain* 550), labelled *E. serratum* var. *minutissimum*, which we have examined from several herbaria, is not that species but is young and poorly developed *E. spinulosum*. We have encountered much material of the latter misdetermined as *E. serratum;* nearly all of it contains only juvenile plants or, in some instances, poor and sparse material of only lowermost leaves. The lower leaves of some forms of *E. spinulosum* have a striking resemblance to *E. serratum*. Plants collected by A. J. Sharp in Tennessee (*Sharp* 341121) and determined by Grout as *E. intermedium* Mitt. are young and undeveloped *E. spinulosum*. They are evidently the specimens upon which Grout (1940) based the Tennessee report of *E. intermedium*, a partially costate *serratum*-type species. Since we rather often observe the barest suggestion of a costa in *E. serratum*, we attach no significance to this character. We have seen similar evidence of a very faint costa in all of the so-called ecostate Ephemeraceae, especially in the four species of *Nanomitrium*. Having examined only a few specimens of *E. intermedium* from Europe, we are in no position to rule on its worth as a species. However, in the light of our observations of the tendency of the "ecostate" Ephemeraceae to show evidences of a costa, we feel that *E. intermedium* should receive additional study.

Grout (1935) has already referred to the fact that plants of *E. serratum* from California are much less strongly serrate than plants of this species from eastern America. His observation, however, was based on a single collection by Bolander, made near Mission Dolores, San Francisco, in 1863 (DUKE). Not only are Bolander's plants less serrate but they are broadly and shortly acuminate. Some leaves are almost acute. Most leaves are broadest above the middle, and the leaf cells are quite narrow and prosenchymatous, possessing the tightest areolation of any plants of *E. serratum* that we have examined. Upon first examining the Bolander specimens, we were immediately struck by the close resemblance they bear to the illustrations of var. *angustifolium* in the *Bryologia Europaea*, presumably based on a Sardinian collection as previously noted. Judging from the illustrations, the leaves

of the Sardinian plants are longer and more sharply acuminate but otherwise show a remarkable resemblance to the Californian plants. That there are strong phytogeographic affinities between vegetational elements of the California coast and the Mediterranean region has long been established. We were compelled, therefore, to consider the possibility that the Californian and Sardinian plants might belong to a common separate entity. This notion was soon dispelled, however, when through the kindness of W. C. Steere, we were able to examine a mass collection of this species which he had made in 1953 in Sonoma County, California. Steere's collection was the first since Bolander's discovery of the species in California. The collection contains a wide variety of plants, varying from plants nearly as extreme as those in the Bolander collection to plants that can be matched reasonably well with eastern material. We have seen additional collections from California made by W. B. Schofield, in Santa Clara and Santa Cruz counties. These specimens are similar to the Austin material from New Jersey. Also, Schofield recently sent us plants of *E. serratum* from Nova Scotia, in which the areolation and leaf shape are almost identical with Bolander's plants from California, and the leaf margins are serrate with teeth which are intermediate between the long spinose teeth of eastern plants and the short, blunt teeth of western plants. We are forced to conclude, therefore, that, while nothing in the East matches the extreme forms in California, a gradual series of intergrading forms makes it impractical to segregate the Californian material as a distinct entity.

Excluded Species. *Ephemerum mexicanum* Bartr., The Brylogist 28: 66. 1925. We have examined the type of this curious little species through the courtesy of Mr. E. B. Bartram. In our opinion it does not belong to the Ephemeraceae. The areolation is quite unlike any member of this family. It has quadrate-hexagonal upper leaf cells which are much smaller than any known member of *Ephemerum* and the cells moreover are tightly arranged, not at all lax. The costa in *E. mexicanum* is highly differentiated, showing in cross section 3 or 4 larger median cells with two layers of smaller stereid-like layers on each side. The capsule has a well-developed apiculus, much stronger than in *Ephemerum*. Additional study will be required to place this species with certainty, but it can be excluded from the Ephemeraceae with confidence.

Ranges of interspecific variation. As pointed out earlier, *E. crassinervium* is exceedingly polymorphous, and to a lesser degree, so also are *E. crassinervium* var. *texanum*, *E. spinulosum* and *E. cohaerens*. We have found specimens linking together each

of these taxa. The intergradation occurs even in the characters which in their strongest expression and commonest combinations, delineate the taxa: namely, areolation, serration and shape of the largest leaves.

Leaf shape variants are numerous. Some plants of *E. spinulosum* have leaves much broader than usual (*fig.* 2, 6). One *E. crassinervium* specimen (*Bryan* 611) has leaves which greatly exceed the average length and have a very long narrow awn (*fig.* 18). Others with *E. crassinervium*-type areolation and short, more or less erect serrations have the narrow, almost linear leaves of *E. spinulosum*. Some specimens combine compact areolation and almost linear leaves with modified spines (*fig.* 17). Because of the high value we place on areolation we have referred this form to *E. crassinervium*.

Also the variations extend in the direction of greater breadth, but in this intergradation is not as obvious: the lanceolate *E. crassinervium* leaves tend to grade toward the oblong-lanceolate or spatulate leaves of *E. cohaerens*, yet retain tight areolation and papillosity (*fig.* 24, 27). This form is segregated as *E. crassinervium* var. *texanum*. Few specimens bear characters intermediate between this variety and *E. cohaerens*. Some difficulty, however, is experienced with occasional, aberrant papillose forms of *E. cohaerens*, yet the peculiar diagonal arrangement of the laminal cells below the acumen in *E. cohaerens* always indicates the proper placement of the specimen. Also, laxer areolation always indicates *E. cohaerens*, dense areolation *E. crassinervium* var. *texanum*.

Another series of specimens links *E. spinulosum* and *E. cohaerens*, and in this series the diagonal arrangment of the cells in the middle third of the upper leaves of *E. cohaerens* is important in properly naming the material. Areolation is much the same throughout this series. Width of the leaves, though variable, is sometimes helpful. A collection from Florida (*Reese* 1105, DUKE, FSU) includes many plants with slightly shouldered upper leaves (*fig.* 6). Furthermore, the width of the upper leaves falls in the wider part of the range for *E. spinulosum*, but no diagonal cell arrangement is apparent, and we named the specimen *E. spinulosum*.

To complete the series linking *E. spinulosum* and *E. cohaerens*, we can cite material collected by the senior author in southern Florida. This specimen (*Bryan* 494, DUKE) is typified by a diagonal arrangement of the cells below a decided shoulder. The leaves, however, are quite narrow for *E. cohaerens*, and the spines are reminiscent of the type we associate with *E. spinulosum*. Because of the apparently less variable character of diagonal cell

arrangement, coupled with the distinctly shouldered leaves, we named this specimen *E. cohaerens*. The leaves of these plants resemble figure 34 but have more prominent spines. Variations toward narrower leaves are not uncommon, and the extremes in this direction are leaves that are similar in shape to those of *E. crassinervium* (*fig.* 28) or *E. spinulosum*. Nearly all variants of *E. cohaerens* can be recognized by the suggestion of a shoulder, the tendency for the upper median cells to be diagonal to the costa and by smooth cells.

In addition to combinations of various forms of areolation, serration and leaf shape among the aforementioned taxa, another tendency occurs in *E. crassinervium*. This species, usually with short, not strongly recurved serrations, varies also toward the European *E. sessile* (Bruch & Schimp.) Rabenh., a widely distributed species of central Europe, Italy and England. The early North American manuals included *E. sessile* or its synonym *E. stenophyllum* Schimp., and Brotherus (1924-25) recorded it from "New Yersey, Ohio." Grout (1935) included *E. sessile*, but stated that "no American specimens have been located." These reports seem to have been based upon a specimen from Ohio, Sullivant and Lesquereux's *Musci Boreali Americani* (*Ed.* 1) 21 and other collections made by Austin near Closter, N. J., between 1866 and 1878. Apparently the latter collections were not issued as a part of Austin's exsiccati, but numerous specimens are now in the herbarium of the New York Botanical Garden. Evidently Austin considered describing the plants as new, for the herbarium name, *E. closteri*, appears on many of them. The plants of Sullivant and Lesquereux's no. 21 are badly mixed in the several sets at the New York Botanical Garden, as well as in the set at the Duke herbarium. Each packet that we have examined contains both *E. spinulosum* and *E. crassinervium*. We consider the latter rather typical *E. crassinervium* as regards leaf shape and serration, but the aerolation varies in the direction of *E. spinulosum*. It is difficult to see how this material could have been called *E. sessile*. The Austin collections referred to above also seem to us to be well within the confines of *E. crassinervium*. The leaves are a little shorter than usual and not as serrate as most material of *E. crassinervium*, but the areolation and serrations are quite unlike *E. sessile*. However, two North American specimens which closely resemble the entire-margined *E. sessile* have come to our attention. One was collected by Elizabeth G. Britton at the New York Botanical Garden on January 18, 1900, and the plants in question are among a population of *E. spinulosum*. In all respects except serrations these plants are good *E. crassinervium*, but the margins

are almost entire, only barely serrulate at most. The other specimen approaching *E. sessile* is a cytological specimen, no. 250, collected by the senior author in Durham Co., North Carolina. This specimen matches rather closely *E. sessile* from Europe in areolation, costa and leaf shape. The leaf margins of the British material (Pond Leigh, 1871, *W. M.*, NY) appear to be even more serrulate than those of the North Carolina specimen. Had we found more specimens of this form in North America, we should have named these specimens *E. sessile*. However, considering the wide range of plasticity in *E. crassinervium* and the paucity of entire-margined specimens, we feel that as yet there is insufficient evidence of *E. sessile* in North America.

NANOMITRIUM Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 13: 408. 1874.

Micromitrium Aust., Musci Appal. 45. 1870. (not Spruce, 1867; Spruce *ex* Mitt., 1869).

Ephemerum sect. Pseudephemerum C. M., Hedwigia 39: 235. 1900.

In the genus *Nanomitrium*, *N. synoicum* is the earliest described member. James (1869) assigned it to *Ephemerum*. Austin established the genus *Micromitrium* in 1870 for *M. megalosporum* and *M. austinii*, but because Spruce had previously (1867) used the name in the Orthotrichaceae (as a *nomen nudum*), it was discarded. Lindberg (1874) proposed the name *Nanomitrium* for the three species. One species, *N. megalosporum*, was considered by Salmon (1899) to be intermediate between *Ephemerum* and *Nanomitrium*, but he transferred it, largely because of the ephemeroid exothecium, to *Ephemerum*. As a result of cytological studies (Bryan, 1957) we are convinced that the species properly belongs in *Nanomitrium*. We are transferring *N. wrightii* from *Ephemerum* on the basis of greater morphological similarities. One North American variety, *N. austinii* var. *floridanum* Grout, has been proposed, but we do not feel that this form with somewhat larger leaves is worthy of varietal status.

Several striking characters distinguish *Nanomitrium* and *Ephemerum*. Most obvious is the clear-cut chromosome difference (Bryan, 1957): the five *Ephemerum* taxa have 27 bivalents in meiosis, while *N. austinii* and *N. megalosporum* form a euploidic series, with 11 and 22 bivalents respectively. In erecting the genus *Micromitrium*, Austin (1870) stressed the importance of the small, adherent calyptras. This feature is impressive since in North American *Nanomitrium* the over-all length does not exceed 0.14 mm. and in *Ephemerum* it may reach 0.40 mm. The areolation of the leaves in *Nanomitrium* is more funarioid than in *Ephemerum*:

the leaf cells are large, hyaline and non-papillose. Several differences between the genera are seen also in the sporophytes. *Nanomitrium* has somewhat smaller capsules, appearing to be somewhat flattened apically. Hardly any apiculus is evident, but the cells near the apex show some differentiation, and the upper part of the capsule may be marked by one or two rows of smaller quadrangular cells. This line of dehiscence we have seen in specimens of three North American species, but it is apparently rare in *N. megalosporum*, and non-existent in *N. wrightii*.

Another important sporophytic difference lies in the internal structure of the capsule. In *Ephemerum* the spore sac almost always has two deeply pigmented regions, the remnants of the absorbed columella. In *Nanomitrium*, not even *N. megalosporum* or *N. wrightii*, both with persistent spore sacs, shows remains of the columella. Further dissimilarities were found during the course of cytological studies (Bryan, 1957). The spore mother cells of *N. austinii* and *N. megalosporum* are small in comparison with those of *Ephemerum*, and meiosis occurs in *Nanomitrium* capsules when they are relatively much smaller than in those of *Ephemerum*.

1. Capsule wall of two layers of cells; stomata present; spores exceeding 40 μ in diameter..... 2
1. Capsule wall of a single layer of cells; stomata absent; spores less than 40 μ in diameter..... 3
2. Leaves linear-lanceolate, narrowly acute, ending in a single elongated cell; mature colonies dark green to yellow; stomata confined to the base of the capsule.....*N. wrightii*
2. Leaves broadly lanceolate, sometimes broadest above the middle, acuminate; terminal cell not conspicuously elongated; mature colonies orange-brown; stomata confined to upper half of the exothecium.....*N. megalosporum*
3. Stems long, usually 0.2 to 1.5 mm. high; mature capsules dark red; leaf margins usually entire and recurved above; leaves usually ovate-lanceolate; calyptra often excentric.....*N. synoicum*
3. Stems short or lacking; mature capsules dark brown or black; margins serrulate, scarcely recurved; leaves ligulate-lanceolate; calyptra central.....*N. austinii*

1. **Nanomitrium wrightii** (C. M.) n. comb. *Ephemerum wrightii* C. M., Linneaea 43 (1880-82): 351. 1881(?).

As far as is known this tiny species is confined to Cuba. It was originally collected by Wright, and we have examined a portion of the type at the New York Botanical Garden from the herbarium of Carl Müller. In addition we have studied collections made by Elizabeth G. and N. L. Britton (no. 14607, DUKE) and by Percy Wilson (no. 15632, MICH). The plants are virtually stemless,

bearing 5-6, linear-lanceolate leaves, narrower and more attenuated than in the related species. The leaf margins are entire or slightly serrulate. Narrowly acute or acuminate, the leaves terminate in a single long cell. They reach 2 mm. in length and between 0.15 and 0.26 mm. in breadth. Areolation is somewhat loose and resembles that found in *N. austinii* and *N. synoicum*. Leaf cells of *N. wrightii* are linear-oblong, longest and narrowest of the genus, up to 150 μ in length and from 11-28 μ wide. In many leaves a few median cells are double-layered and suggestive of a costa, a situation also found in other species. According to Mrs. Britton's notes with specimens at the New York Botanical Garden, plants are "synoicous or dioicous, antheridia at base of vaginule." The plants we have examined have been synoicous, as illustrated in figure 44, or "dioicous" (male and female plants on the same protonema). Capsules are globose, with a small apiculus. The calyptra is minute, consisting of little more than the remains of the archegonium. The exothecial cells are quadrangular to hexagonal, 23-50 μ in diameter, with numerous stomata confined to the base of the capsule. The reniform spores are about 50 μ × 60-75 μ and finely papillose. The specimens with mature spores that we examined were collected during the months of February and March.

Despite our having no chromosome data for this species, we are transferring it from *Ephemerum* to *Nanomitrium*. The very small calyptras are found only in *Nanomitrium*, never in *Ephemerum*, and the arrangement, size and walls of the leaf cells resemble *Nanomitrium*. Spore size in *N. wrightii* falls between that of *N. megalosporum* and *N. austinii*, but only slightly below that in *Ephemerum*. When dry the *N. wrightii* leaves shrivel and become contorted in such a way as to give a characteristic flaccid appearance, which we have come to associate with *Nanomitrium*, and in total aspect the plants remind one of *Nanomitrium*. The presence of stomata and the fact that the capsule wall is of two layers of cells are characters that Salmon (1899) identified with the genus *Ephemerum*. Bryan (1957), however, has shown that on cytological grounds *Ephemerum megalosporum* belongs in *Nanomitrium*, and, like *N. wrightii*, *N. megalosporum* has stomata, as well as two layers of cells in the capsule wall. Undoubtedly, *N. wrightii* and *N. megalosporum* stand between *Ephemerum* and the other North American *Nanomitria*.

2. NANOMITRIUM MEGALOSPORUM (Aust.) Lindb., Notis. Sällsk. Fauna et Fl. Fenn. Förh. 13: 408. 1874. *Micromitrium megalosporum* Aust., Musci Appal. 47. 1870. *Ephemerum megalosporum* (Aust.) Salm., Jour. Linn. Soc. London, Bot. 34: 166. 1899.

Salmon (1899) considered this species a link between the two genera. It has been treated in both. Salmon placed great importance in the distinctly ephemeroid capsule: its areolation, the presence of a spore sac at maturity and the presence of stomata. Still another similarity of *N. megalosporum* to *Ephemerum* is the size of spores. Despite these shared traits we are convinced that the species belongs in *Nanomitrium* because of its calyptra, cytological characteristics (Bryan, 1957), leaf areolation and capsule shape.

Nanomitrium megalosporum, relatively common in the Gulf, southeastern and middle Atlantic states is known north of Connecticut from only one collection made at Kittery, Maine. We have seen a single specimen from Cuba (CAN).

We have studied Austin's type specimen (NY), which was sent to Roth for two of the drawings included in *Die aussereuropäischen Laubmoose* (1911). The plants possess short stems, shorter than those of *N. synoicum*. The leaves have a broad, almost ovate base and are gradually narrowed to the apex and clearly serrulate in the upper half. In length of largest leaves this species is a little smaller than *N. austinii* or *N. synoicum*, since the upper leaves measure between 0.6 mm. and 1.1 mm. In width *N. megalosporum* leaves are the largest, up to 0.36 mm. We should mention, however, one exceptional specimen of *N. austinii*, from Florida, with leaves up to 0.4 mm. (*Schornherst* 855, FSU, DUKE). All leaves of *N. megalosporum* are virtually ecostate. At the middle of the upper leaves the cells reach about 30 μ in diameter and are 3-6 times as long; those above are a little smaller. Closely resembling in form those of other species of the genus, the calyptras are only a little larger, about 0.14 mm. in over-all length. The capsules, sessile and slightly flattened apically, are orange-brown when mature and about 0.35 mm. in diameter. Like *Ephemerum*, *N. megalosporum* possesses stomates in the exothecium wall. Within the outer wall the spore sac encloses more or less reniform spores, as large as 50 × 81 μ, and distinctly marked with projections ranging from fine papillae to coarse tubercules.

Nanomitrium megalosporum appears to reach maturity earlier in the autumn than other continental North American members of the family. We have seen North Carolina collections in which some of the plants were mature in August (*Bryan & Schuster* 187, DUKE). By the end of September most of the plants have reached maturity. It is likely that the capsules are resistant to disintegration, as evidenced by collections of mature plants made throughout the year.

The mature specimens have a peculiar color distinction. Al-

most all we have studied have orange- or yellow-brown leaves and sporophytes when the capsules are ripe.

Good examples of *N. megalosporum* are found in Grout's *North American Musci Perfecti* 238 (TENN, CAN) and in Holzinger's *Musci Boreali-Americani* 326 (NY, DUKE). Holzinger's no. 276 (DUKE) is mixed with *N. austinii*. A specimen from Sanford, Florida, collected by Rapp and issued by Bauer, *Musci Europei et Americani* 2166 (NY), fails to show a line of dehiscence in the exothecium. Another of Rapp's collections (NY), made in April, 1927, at Sanford, furnished at least two capsules with a distinct line of horizontally elongated, rectangular cells above the equator. Although we searched very carefully we could not find similar cells on other capsules.

3. NANOMITRIUM AUSTINII (Sull.) Lindb., Notis, Sällsk. Fauna et Fl. Fenn. Förh. 13: 408. 1874. *Micromitrium austinii* Sull. *in* Aust. Musci Appal. 45. 1870. *Ephemerum grandifolium* C. M., Bull. Herb. Boiss. 6: 20. 1898. *Ephemerum capituligerum* C. M., Hedwigia 39: 235. 1900. *Nanomitrium capituligerum* (C. M.) Broth., *in* E. & P., Nat. Pfl., Ed. 1, 1 (3): 515. 1909. *Nanomitrium grandifolium* (C. M.) Broth. *in* E. & P., Nat. Pfl. 10: 320. 1924. *Nanomitrium austinii* var. *floridanum* Grout, Moss Fl. N. Amer. 2(2): 71. 1935.

Rather different from *N. wrightii* and *N. megalosporum*, this species and the next, *N. synoicum*, are apparently related, yet quite distin. *Nanomitrium austinii* and *N. synoicum* have a single-layered capsule wall at maturity; the spore sac and columella are absorbed before spore cleavage. The large cells of the capsule wall are unbroken by stomata. Smaller spores also serve to separate these species from their congeners.

Another helpful character can be of use in distinguishing *Nanomitria* in the field. As already described, mature colonies of *N. megalosporum* usually have a yellow or orange cast, and color differences can also be used for two other species. For these species, though, it is the color of the mature capsules which sets them apart. In *N. austinii* the capsules are dark brown or black; in *N. synoicum* they are dark red.

The geographic range of *N. austinii* appears to be broader than that of *N. megalosporum*. We have seen specimens from Missouri eastward through Ohio, Pennsylvania and New York, and southward through Tennessee, North Carolina and Florida. We have observed specimens labeled *N. capituligerum*, from Panama and Puerto Rico. Evidently, this species is the most common *Nanomitrium* in North America. The colonies may be mixed with *N.*

megalosporum, *N. synoicum*, *Ephemerum spinulosum*, *E. crassinervium*, *Aphanorhegma* and *Riccia*.

Austin's *Musci Appalachiani* 45, from which *N. austinii* was described, contains predominantly immature spores. The average diameter is 27 μ. Therefore, the spore dimensions given in the type description are rather low for the species, but fortunately, the dimension is not unusually small. We have seen mature spores as small as 25 μ and as large as 39 μ. The spores in the type are, probably because of immaturity, finely papillose, and do not represent the characteristic markings on mature spores. Distinctly papillose to coarsely tuberculate describes most of the spores examined. Mature spores, produced in late summer or autumn, are elongately reniform to almost spherical, and the dark brown or black capsule, which does not exceed 0.3 mm., has a delimited operculum. It is difficult to demonstrate the line of dehiscence, because the spores in the capsule obscure the areolation, and the empty capsule wall is exceedingly fragile. The cells of the capsule wall are larger than those in *N. megalosporum*, up to 78 × 97 μ, but mostly smaller than in *N. synoicum*. The calyptra of *N. austinii* is usually central and about 0.12 mm. in over-all length. Contrary to most descriptions of this species, the leaves are not invariably ecostate. Many of the specimens we have seen have upper leaves with a weak costa extending for a few cells in the middle. These upper leaves are ligulate-lanceolate, usually recurved and as large as 2 × 0.33 mm., mostly smaller. One specimen from Florida (*Schornherst* 844, DUKE), has leaves up to 0.4 mm. in width. The margins are slightly serrulate by projecting cell apices, and the cells at the middle of the leaves are 16-24 μ (rarely to 32 μ) wide and 4-6 times as long.

Grout (1935) described *N. austinii* var. *floridanum* as a larger form with rough spores and with leaves more than 1 mm. × 0.3 mm. As a result of our examination of the type (Grout's *North American Musci Perfecti* 289, DUKE) we feel that the differences are insufficient to indicate varietal status. The leaves are long, up to 2 mm. The spores are warty and as large as 32 μ, characteristics we find both in plants with long leaves, as the type material, and with smaller leaves (*Rapp*, Jan. 1935, Fort Reed, Fla., DUKE; *Gray* FM25b, Jan. 28, 1931, Winter Haven, Fla., DUKE). Large warty spores are not confined to specimens from southern localities, as shown by Beal's specimen collected on Staten Island, New York, November 5, 1938 (DUKE). Holzinger's *Musci Acrocarpi Boreali-Americani* 376, issued as *N. grandifolium* but cited by Grout as var. *floridanum* (and incidentally mixed with *N. megalosporum*), is characterized by plants with leaves up to

1.5 mm. long and warty spores which reach 39 μ but are mostly smaller. Although many of the southern collections have larger leaves, we feel that without concomitant characters, we cannot recognize the variety.

Although we have seen only a few specimens of *N. capituligerum*, we have little hesitation in merging it with *N. austinii*. We are unable to find any distinctions that will separate the two species. Müller described the sexual condition as "dioicous," but we have observed some synoicous plants in all of the collections studied.

4. NANOMITRIUM SYNOICUM (James) Lindb., Notis. Sällsk Fauna et Fl. Fenn. Förh. 13 : 408. 1874. *Ephemerum synoicum* James, Trans. Amer. Phil. Soc. 9 (1864) : 106. 1869. *Micromitrium synoicum* (James) Aust., Musci Appal. 46. 1870.

Outstandingly long stems are typical of this species, so that it is hardly ever confused with its congeners. Besides the long stems, about 0.5 mm., other characters are usually helpful. We have observed that the leaf margins in the upper two-thirds of the upper leaves are usually somewhat recurved, and that the mature capsules are uniquely red-brown.

A paucity of specimens in North American herbaria seems to indicate rarity of this species, since equally inconspicuous mosses from the same habitats are more abundantly represented. The collection records include specimens from Iowa, Missouri, Kentucky, Ohio, Pennsylvania, New Jersey, North Carolina and Georgia. Intermixtures with *Bruchia*, *Weissia* and *Nanomitrium austinii* are not uncommon.

The leaves in *N. synoicum* are virtually ecostate and linear-lanceolate and may be as large as 1.8 × 0.25 mm. (Exceptional specimens from Iowa have leaves up to 0.4 mm. wide.) The margins are slightly serrulate to entire. At the middle of the upper leaves the leaf cells range from (11)15-21 μ in width and are from 4-6 times as long. Similar in size to that of *N. austinii*, the calyptra is often excentric on the mature capsule, but this feature is not as obvious as earlier manuals implied. The capsule differs little in areolation from *N. austinii*, but the spores are a little smaller, 23-37 μ. They mature in autumn and at maturity are papillose to tuberculate.

Most of the material included in this part of the investigation provoked no problems in identification. However, we found specimens from Iowa (*Conard* 45-42, 7-54, DUKE; *Gilman* 39310, MICH, and others) that do not conform strictly to the specific description. These specimens, all similar, depart in having quite broad leaves which are serrate to below the middle. Since in all

other respects they are typical, we have referred them to *N. synoicum*. Austin's *Musci Appalachiani* 46 (DUKE) consists of only a few plants of *N. synoicum* among many plants of *Bruchia* and *Weissia*. The *Nanomitrium* is typical, as it is also in Holzinger's *Musci Acrocarpi Boreali-Americani 327* (DUKE).

Almost no intergradation has been observed among the North American species of *Nanomitrium*. *Nanomitrium megalosporum* is very distinct. Between *N. austinii* and *N. synoicum* the distinguishing characters are not strong, but they appear to occur constantly, and provide adequate means for determining the species.

Discussion

In *Ephemerum* and, to a lesser extent, *Nanomitrium* even the diagnostic characters are not invariable, but intergrade: whether through genetic or environmental effects is not known. Few attempts have been made to distinguish between environmental and genetic modifications in any mosses, and even the broadest patterns of morphological responses to environmental changes are imperfectly known.

For such minute mosses the weather conditions during the growing period are at least partially responsible for the variants. The Ephemeraceae have a relatively short growing period, probably no more than 60 days from the time the protonema begins to form to maturity of the spores. Growth of the leaves is accomplished in even less time, as evidenced by young specimens in which at the time of meiosis the leaves have already attained mature characteristics. Likewise the leaves of plants which still bear merely archegonia approach mature characters so that the species are recognizable from these plants. Therefore, the growth is very rapid and must be affected by weather conditions of limited duration.

Small micro-environmental differences also are important in influencing the expression of characters. Minute variations in soil components, the proximity of pebbles, affecting the amount of moisture available and the degree of insolation, account for some variations both within and between colonies. The influence of micro-environmental fluctuations would be expected to be more apparent in species growing more or less isolated, as contrasted to the gregarious types or those with an abundant persistent protonema. That the protonema provides a more uniform environment during development could account in part for the greater relative variability in *E. crassinervium*, as compared with that in

E. spinulosum, *E. cohaerens* and *E. serratum*, more gregarious species with abundant protonemata.

Since there are no studies of the effect of environment on the morphology of *Ephemerum* or *Nanomitrium*, we must consider that environment is probably responsible for at least part of the variation. Within the relatively small area of a colony, the potential variability of a taxon would have little amplitude; but in another habitat, different in micro-environment, a very different expression of characters would be expected. That these variations are in the direction of other taxa could indicate that they share genetic material.

Environment is probably not solely responsible for the multifarious intermediate forms, and so the explanation must lie in the genetic relationships. We have considered the possibility that the taxa are hybridizing, but the present evidence is not conclusive. The meiotic studies (Bryan, 1957) have shown that in all members of the Ephemeraceae there are apparently no meiotic anomalies such as are typical of hybrids, but the chromosome number is the same for all North American *Ephemera*, $n = 27$, and forms a euploidic series for the *Nanomitria*, $n = 11$ and $n = 22$. The components of a given colony usually do not speak for hybrid origin, since all plants of one taxon more or less represent a single form of variability. Possibly, such unmixed colonies have a monosporic origin, all plants arising from one protonema, or, in colonies of more than one taxon, each has a monosporic origin. Wide dispersal of spores, as monosporic colonies presuppose, is quite possible in these genera since the spores are scattered largely by flooding and wind. Thus, if a capsule were of hybrid origin, the variation of the offspring would not be seen in any one resultant colony. However, many colonies are seen in which the capsule walls have disintegrated, and the spores lie clustered around the parent plants. Colonies arising from these spores would portray any hybrid variability.

If hybridization occurs to any great extent in nature, it is difficult to see how the species could have been maintained, for they grow in such mixtures and in such close proximity that intercrossing might be expected to occur with high frequency, unless there is some genetic barrier. The opportunities for hybridization are so great that without such a barrier the resulting free exchange of genes would soon completely degrade the species. The presence of persistent protonemata in all the species of the family favors a a high degree of self-fertilization. We have already explained that in all the species studied antheridial branches are found at the base of archegonial plants, or the antheridia occur on separate

plants on the same protonematal branch. It seems certain, as we have already pointed out, that none of the species of the North American Ephemeraceae is *genetically* dioicous. In any event, perigonial branches or plants are produced in profusion on the same protonematal branches with the archegonial plants and thus greatly reduce the opportunity for hybridization and could explain the persistence of the several specific entities even in the face of complete interfertility.

That the *Ephemerum* taxa, probably excluding *E. serratum*, may represent one polymorphous entity is not to be overlooked, and coinciding geographical ranges, mixed colonies, intermediate forms, a constant generic chromosome number and regular meiosis attest to the possibility. The same might be true for the *Nanomitria*. However, since most plants can be identified easily, we believe the division into species to be so obvious as to reflect a natural separation.

Throughout our investigations we have been aware of the great need in this family for cultural and hybridization studies. To know such elementary facts as the extent of the protonema from one spore and the range of variation of plants on one protonema in constant and controlled variable environments are imperative to a complete understanding of the intrageneric relationships. Most important is a study of the crossability of the species, followed by morphological studies of hybrid offspring, if any. The morphological and cytological data indicate to us that these entities are entitled to specific, or varietal status, as we have indicated in this paper.

Literature Cited

Austin, C. F. 1870. Musci Appalachiani. Tickets of specimens . . . 92 *pp.* Closter, N. J.

Barnes, C. R. & F. D. Heald. 1896. Analytic keys to the genera and species of North American mosses. Bull. Univ. Wis. Sci. Ser. 1(5): 157-368.

Beals, A. T. 1924. How I find *Ephemera*. The Bryologist 27: 46-49.

Braithwaite, R. 1887-1905. The British Moss Flora. 3 *vol. Illus.* London.

Brotherus, V. F. 1924-25. Andreaeales: Bryales. *In* Engler & Prantl, Die natürlichen Pflanzenfamilien. *Vol.* 10, 11. Leipzig.

Bryan, Virginia S. 1957. Cytotaxonomic studies in the Ephemeraceae and Funariaceae. The Bryologist 60: 103-106. *Fig.* 1-17.

Dixon, H. N. 1924. The Student's Handbook of British Mosses. Ed. 3. xlvi + 582 *pp.* 63 *pl.* Eastbourne.

Gray, F. W. 1932. Pygmies, here and there, now and then. The Bryologist 35: 18-23.

GROUT, A. J. 1933-40. Moss Flora of North America. . . . *3 vol.* Newfane, Vt.

HAMPE, E. 1837. Musci frondosi Germaniae ad methodum naturalem dispositi. Flora *20*: 273-287.

HEDWIG, J. 1801. Species Muscorum Frondosorum . . . vi + 353 *pp. Pl.* 1-77. Leipzig.

JAMES, T. P. 1869. On new mosses. Trans. Amer. Phil. Soc. 13: 105-116. (1864).

JENNINGS, O. E. 1913. A manual of the Mosses of Western Pennsylvania. . . . 375 *pp.* 54 *pl.* Pittsburgh.

KINDBERG, N. C. 1897. European and Northamerican Bryineae (Mosses). *Parts* 1, 2. Linköping.

LESQUEREUX, L. & T. P. JAMES. 1884. Manual of the Mosses of North America. v + 447 *pp.* 6 *pl.* Boston.

LINDBERG, S. O. 1874. Manipulus muscorum secundus. Notis. Sällsk Fauna et Fl. Fenn. Förh. 13: 351-418.

MÜLLER, C. 1881(?). Prodromus bryologiae argentinicae II, seu Musci Lorentziani argentinici. Linnaea 43: 341-486. (1880-82).

NICHOLS, G. E. 1910a. Field notes on *Ephemerum* and *Nanomitrium*. THE BRYOLOGIST 13: 5-6.

———. 1910b. Notes on Connecticut mosses. Rhodora *12*: 146-154.

RAU, E. A. & A. B. HERVEY. 1880. Catalogue of North American Musci. 52 *pp.* Taunton, Mass.

RENAULD, F. & J. CARDOT. 1892-93. Musci Americae Septentrionalis, ex operibus novissimus recensiti et methodice dispositi. Rev. Bryol. 19: 65-96; 20: 1-?!

ROTH, G. 1911. Die aussereuropäischen Laubmoose. *Vol.* 1. Dresden.

SALMON, E. S. 1899. Notes on the genus *Nanomitrium*, Lindberg. Jour. Linn. Soc. London, Bot. 34: 163-170.

SCHIMPER, W. P. 1860. Synopsis Muscorum Europaeorum . . . 728 *pp.* 8 *tables. Map.* Stuttgart.

SCHREBER, J. C. D. 1770. De Phasco Observationes. *22 pp. 2 pl.* Leipzig.

SCHWAEGRICHEN, F. 1811. J. Hedwig . . . Species Muscorum Frondosorum . . . Supplementum . . . *Vol.* 1. Leipzig.

SPRUCE, R. 1867. Catalogus Muscorum fere omnium quos in terris Amazonicis et Andinis . . . legit Ricardus Spruce. *22 pp.* London.

SULLIVANT, W. S. 1856. The Musci and Hepaticae of the United States. . . . Contributed to the Second Edition of Gray's Manual of Botany. iv + 113 *pp. Pl.* 1-8. New York.

FIG. 1-10. *Ephemerum spinulosum*, upper leaves. 1. *Britton et al.* 10096, Pinar del Río, Cuba, DUKE. 2. *Rapp* 30, Sanford, Florida, NY. 3. *Sharp*, Oct. 20, 1956, Tennessee, DUKE. 4. *Anderson & Bryan* 12600, North Carolina, DUKE. 5. Grout, *Musci Perf.* 237, Florida, DUKE. 6. *Reese* 1105, Florida, FSU. 7. *Anderson* 12680, Mississippi, DUKE. 8. *Grout*, Jan. 18, 1934, Florida, DUKE. 9. Drummond, *Musci Amer.* 2, Louisiana, NY. 10. Holzinger, *Musc. Bor.-Amer.* 126, Minnesota, CAN.

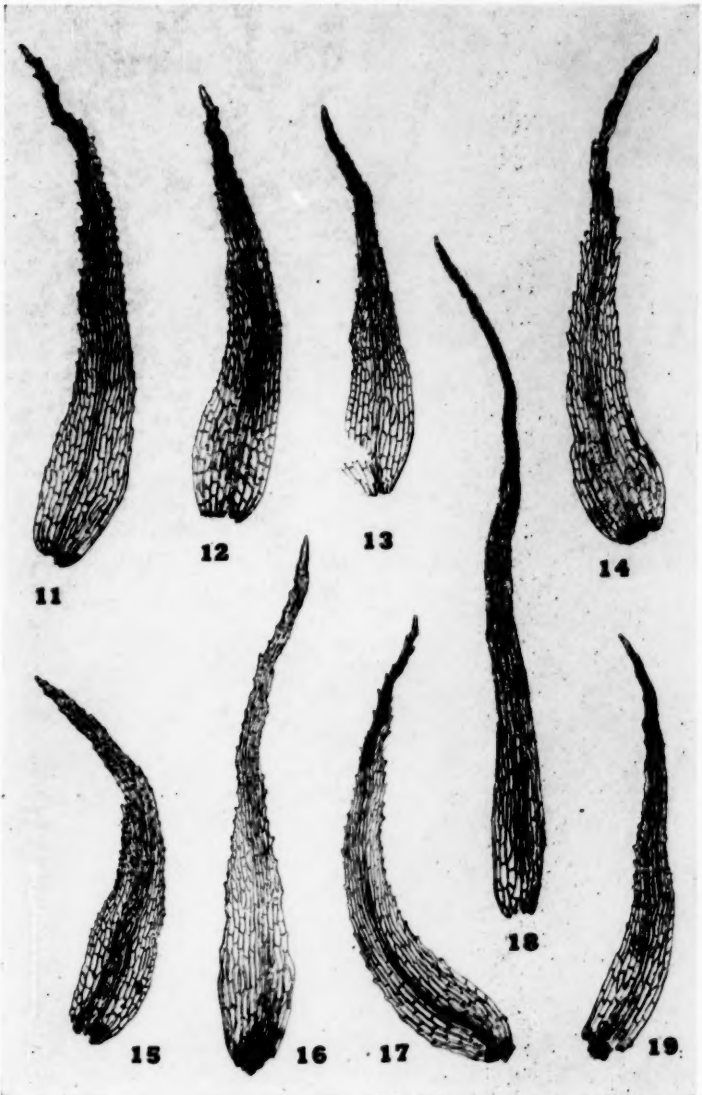

FIG. 11-19. *Ephemerum crassinervium*, upper leaves. 11. *Bryan* 202, North Carolina, DUKE. 12. *Fabius* 2074, Québec, DUKE. 13. *Anderson & Bryan* 12607, North Carolina, DUKE. 14. *Clebsch* 840, *p.p.*, Tennessee, TENN. 15. *Anderson & Bryan* 12610, North Carolina, DUKE. 16. *Bryan* 435, North Carolina, DUKE. 17. *Bryan* 202, North Carolina. 18. *Bryan* 611, North Carolina, DUKE. 19. Austin, *Musci Appal.* 48, New Jersey, DUKE.

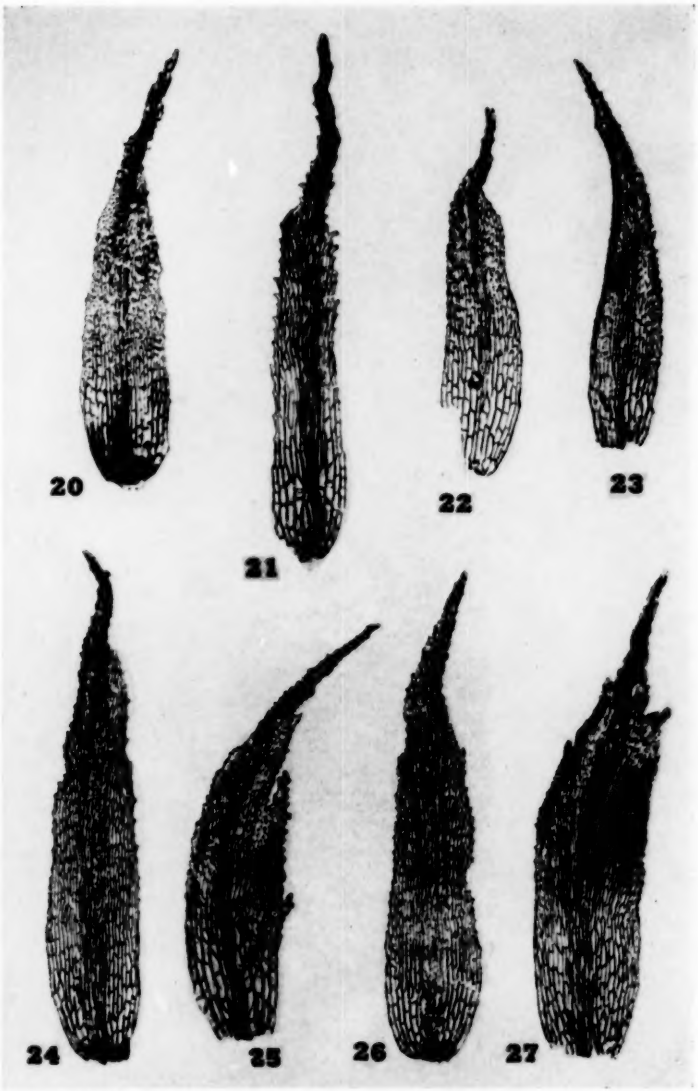

FIG. 20-27. *Ephemerum crassinervium* var. *texanum*, upper leaves. 20. *Bryan* 320, North Carolina, DUKE. 21. *Rapp* 103, Florida, NY. 22. *Ravenel* 196, 197, South Carolina, NY. 23. *Breen* 908, Florida, DUKE. 24. *Bryan* 474, North Carolina, DUKE. 25. *Breen* 908, Florida, DUKE. 26. *Bryan* 474, North Carolina, DUKE. 27. Grout, *Musci Perf.* 275, Texas (*McAllister*, type), DUKE.

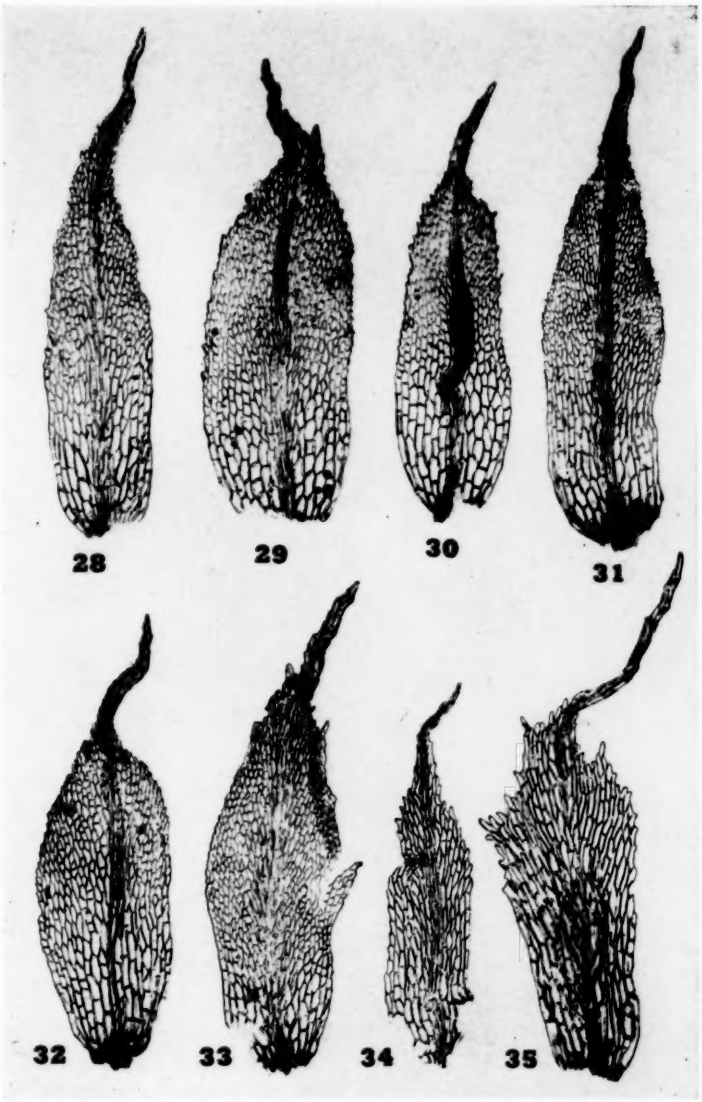

FIG. 28-35. *Ephemerum cohaerens*, upper leaves. *28. James*, Sept. 1870, Pennsylvania, NY. *29. Nichols*, Sept. 25, 1910, Connecticut, DUKE. *30. Nichols*, Sept. 1910, Connecticut, NY. *31. Bryan* 473, North Carolina, DUKE. *32. James*, April 1870, Pennsylvania, NY. *33. Nichols*, Sept. 1910, Connecticut, NY. 34-35. *Clebsch* 840, Tennessee, TENN.

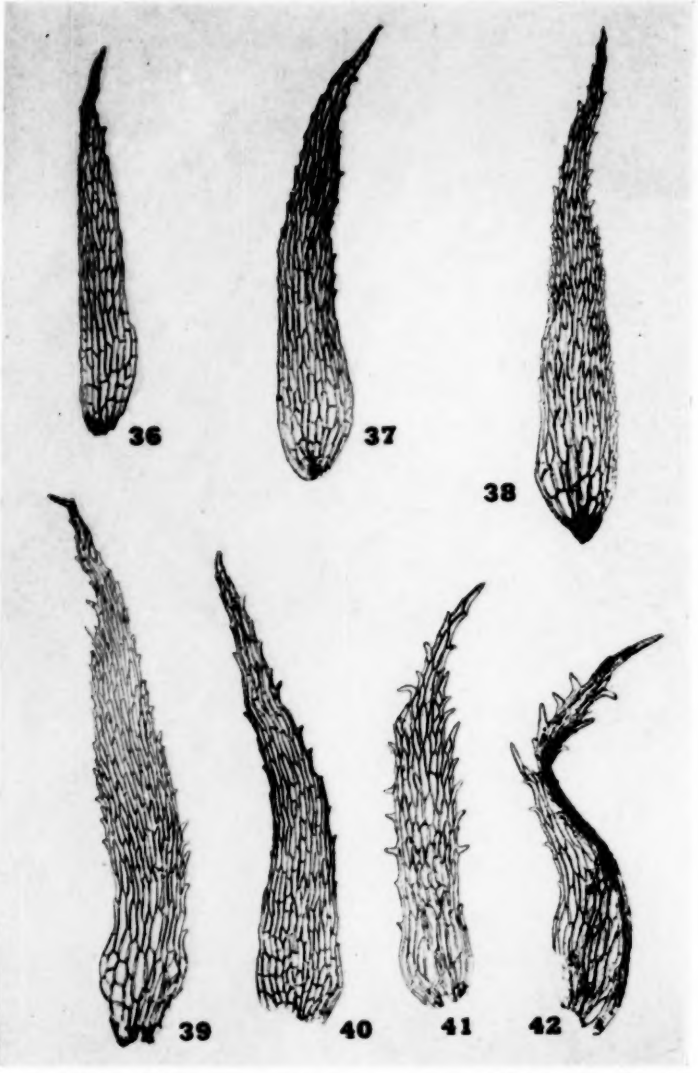

FIG. 36-42. *Ephemerum serratum*, upper leaves. 36-37. *Steere*, Feb. 22, 1953, California, DS. 38-39. *Schofield* 5985, Nova Scotia, DUKE. 40. *Schofield* 5723, California, DUKE. 41. Austin, *Musci Appal.* 47. New Jersey, DUKE. 42. *Huntington*, Oct. 19, 1901, Massachusetts, NY.

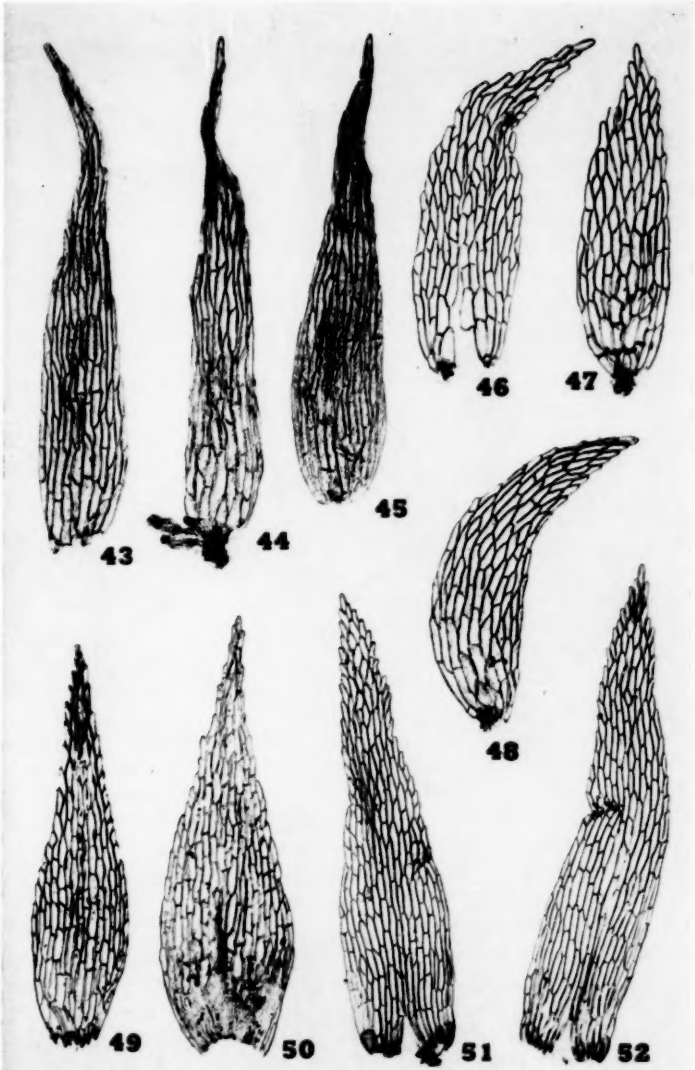

FIG. 43-52. *Nanomitrium*, upper leaves. 43-45. N. WRIGHTII. *Britton et al.* 14607, Isle of Pines, Cuba, DUKE. 46-48. *N. megalosporum*. 46. *Bryan* 607, North Carolina, DUKE. 47. Grout, *Musci Perf.* 238, Florida, TENN. 48. *Rapp*, Apr. 1927, Florida, NY. 49-50. N. SYNOICUM. 49. *Nichols*, Sept. 19, 1910, Connecticut, MICH. 50. *Sull. & Lesq. Musci Bor. Amer.* Ed. 2. 27, Ohio, MICH. 51-52. N. AUSTINII. 51. *Anderson* 12582, North Carolina, DUKE. 52. *Bryan* 186, North Carolina, DUKE.

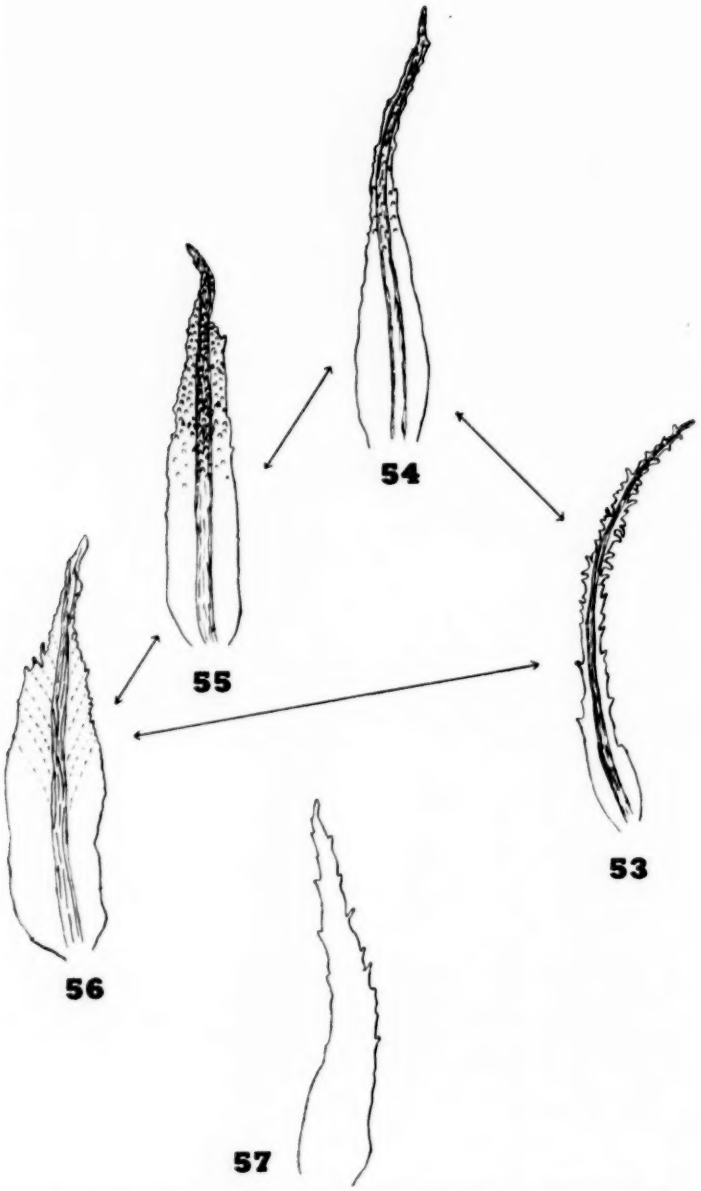

FIG. 53-57. Diagrammatic representations of typical upper leaves of *Ephemerum*. 53. *E. spinulosum*. 54. *E. crassinervium*. 55. *E. crassinervium* var. *texanum*. 56. *E. cohaerens*. 57. *E. serratum*. Connecting lines indicate intergrading forms.

CYTOTAXONOMIC STUDIES IN THE EPHEMERACEAE AND FUNARIACEAE[1]

VIRGINIA S. BRYAN[2]

Most modern systematic treatises of the Musci place the Ephemeraceae and the Funariaceae together in the Funariales. The minute and inoperculate *Ephemerum* and *Nanomitriopsis* accompany in the Ephemeraceae the weakly operculate *Nanomitrium;* and *Physcomitrellopsis, Aphanorhegma, Micropoma* and *Physcomitrium* of the Funariaceae form a series of increasing sporophyte complexity leading to the peristomate Funariaceae. The families' resemblance is shown by leaf areolation and also by the parallel development of sporophytes in *Ephemerum* and *Funaria.* In the Ephemeraceae the leafy gametophyte and the sporophyte are smaller and structurally less complex. This simplicity plus the parallel developmental morphology of the two families indicates that the Ephemeraceae are probably reduced forms.

During the last three years, as a part of a larger study, I have investigated the chromosomes of 13 taxa in the Ephemeraceae and Funariaceae. Ten were previously unknown cytologically, and two have different chromosome numbers. All five of the North American taxa of *Ephemerum* were studied, as well as two of the four species of *Nanomitrium.* In the Funariaceae I have studied species from all North American genera except *Pyramidula,* including *Aphanorhegma serratum, Physcomitrella patens, Physcomitrium immersum, Physcomitrium turbinatum, Entosthodon drummondii* and a polymorphic series of *Funaria hygrometrica.*

The cytological data I have applied to several systematic problems. Outstandingly helpful, the data establish the systematic position of *Nanomitrium megalosporum.* On the generic level the cytological data are useful in substantiating a congeneric status for *Aphanorhegma serratum* and *Physcomitrella patens.* For the relationships of the families, too, the results are helpful. Many early bryologists ignored the similarities of the Ephemeraceae and Funariaceae, and even in this century the Ephemeraceae and simpler Funariaceae were sometimes relegated to a separate order, usually called the Cleistocarpi. Of the bryologists who recognized the true affinities of the inoperculate mosses, some felt that members of the Ephemeraceae were related to the Bruchiaceae (Dicranaceae) or to

[1] Grateful acknowledgment is made to (1) the National Science Foundation for partial support of this work by a grant of research funds (NSF G2894) to Duke University and to (2) the Duke University Council on Research for travel funds.

[2] Dept. of Botany, Duke University, Durham, N. C.

the Pottiaceae. A comparison of cytological data for those families (Bryan, 1956a, 1956b) with the results of this investigation shows greater affinity of the Ephemeraceae and Funariaceae.

I am grateful to L. E. Anderson for valuable criticisms and advice, and to the following for collections of young fruiting Ephemeraceae and Funariaceae: L. E. Anderson, H. L. Blomquist, R. B. Channell, H. A. Crum, W. B. Schofield, R. S. Whitmire and R. L. Wilbur.

The cytological studies were made with a microscope equipped as follows: N.A. = 1.30 Ach. Sl. Th. 1.25 condenser, and N.A. = 1.30, 1.4 mm. oil immersion objective, a 15 × compensating ocular, Kodak Wratten filter no. 74 and camera lucida. A specimen from each population studied has been deposited in the Duke University herbarium and is referred to in this report by a cytological specimen number. The individual plants of the Ephemeraceae from which the chromosome data were obtained have been preserved in Hoyer's solution on glass slides.

Table 1 lists the chromosome numbers for 13 taxa, 10 previously unknown cytologically and two different from earlier reports. All the haploid numbers were determined from meiotic divisions. A cytological specimen number identifies the specimen, and the collection locality indicates the geographical area from which the chromosome number is known. Specimens for which no collector is cited were collected by the author.

Ephemeraceae

All species of *Ephemerum* and *Nanomitrium* are minute, rarely reaching 2 mm. in height. In the field they are visible only as a dark green mat on recently disturbed or sparsely vegetated soil. By examination with a hand lens of the tufted protonemata mat the leafy plants can be distinguished and are most conspicuous when the immersed, immature capsules are bright and shining green. The leaves, although similar in cell arrangement to the Funariaceae, are simpler in structure. Although very narrow, in most species they envelop the capsule. The mature sporophyte has no columella; however, unlike the situation in *Archidium*, the columella is formed during the development of the capsule and usually disappears before maturity. Large spores characterize both genera, but in *Nanomitrium* they are not unusually large. *Ephemerum* spores, on the other hand, rival those of *Archidium* in size.

Ephemerum. This genus is separated from *Nanomitrium* because of its completely cleistocarpous and apiculate capsules with relatively large calyptras. Two species of *Nanomitrium*, *N. megalosporum* and *N. wrightii*, show intermediate characters. Because of its emphemeroid exothecium *N. megalosporum* was transferred to *Ephemerum* (Salmon, 1899), but its affinity with *Nanomitrium* is clarified by the cytological data.

Beginning in September *Ephemerum* with maturing capsules

TABLE 1. New or Different Chromosome Numbers in the Funariales.

NAME AND SOURCE OF MOSS	SPECIMEN NUMBER	CHROMOSOME NUMBER	FIGURE
Ephemerum serratum (Hedw.) Hampe	...	$n = 27$	1
Santa Clara Co., Calif. collector:			
W. B. Schofield	528	.....	..
Ephemerum cohaerens (Hedw.) Hampe	...	$n = 27$	2
Durham Co., N. C. collector:			
L. E. Anderson	473	.....	..
Collier Co., Fla.	494	.....	..
Ephemerum crassinervium (Schwaegr.) Hampe	...	$n = 27$	3
Durham Co., N. C.	202	.....	..
Durham Co., N. C.	203	.....	..
Durham Co., N. C. collector:			
R. B. Channell	250	.....	..
Durham Co., N. C.	611	.....	..
Ephemerum crassinervium var. *texanum* (Grout) Bryan & Anderson	...	$n = 27$	5
Charlton Co., Ga.	226B	.....	..
New Hanover Co., N. C.	320	.....	..
Ephemerum spinulosum Schimp.	...	$n = 27$	4
Columbus Co., N. C. collector:			
H. L. Blomquist	182	.....	..
Columbus Co., N. C.	187	.....	..
Columbus Co., N. C.	188	.....	..
Charlton Co., Ga.	226A	.....	..
Kingsmere, Quebec collector:			
H. A. Crum	437	.....	..
Nanomitrium megalosporum (Aust.) Lindb.	...	$n = 22$	6
Durham Co., N. C.	607	.....	..
Nanomitrium austinii (Sull.) Lindb.	...	.....	..
Columbus Co., N. C.	189	$n = 11$	..
Columbus Co., N. C.	190	$n = 11$	..
Durham Co., N. C.	191	$n = 11$	..
Wake Co., N. C. collector:			
R. L. Wilbur	196	$n = 11$	7, 9
Durham Co., N. C.	610	$n = 10$	..
Durham Co., N. C.	609	$2n = 22$	8
Aphanorhegma serratum (Hook. & Wils.) Sull.	...	$n = 27$	10
Durham Co., N. C.	192	.....	..
Durham Co., N. C.	193	.....	..
Durham Co., N. C.	194	.....	..
Durham Co., N. C.	205	.....	..
Durham Co., N. C.	206	.....	..
Physcomitrella patens BSG.	...	$n = 27$	11
Washtenaw Co., Mich. collector:			
R. S. Whitmire	429	.....	..

TABLE 1. (Continued)

NAME AND SOURCE OF MOSS	SPECIMEN NUMBER	CHROMOSOME NUMBER	FIGURE
Physcomitrium immersum Sull.	...	$n = 54$	12
Gracefield, Quebec collector:			
H. A. Crum	438	.....	..
Physcomitrium pyriforme Brid.	...	$n = 27$	13
Durham Co., N. C.	382	.....	..
Bladen Co., N. C.	543	.....	..
Bladen Co., N. C.	544	.....	..
Entosthodon drummondii Sull.	...	$n = 27$	14
Harnett Co., N. C.	363	.....	..
Funaria hygrometrica (L.) Hedw.	...	.....	..
Durham Co., N. C. collector:			
L. E. Anderson	550	$n = 28$	16
Durham Co., N. C. collector:			
L. E. Anderson	551	$n = 56$	15
Durham Co., N. C.	553	$n = 56$	17

can be found in eastern North America from Saskatchewan and Québec southward to Florida and Louisiana. In the South plants continue to fruit throughout the winter and into the early spring. The Californian *Ephemerum, E. serratum,* also fruits during the winter. In the southeastern states populations occur on the black muck of *Nyssa aquatica* swamps, which in the early summer are dry but are periodically flooded in the late summer or fall and inundated in the winter. The banks of streams and ponds subject to inundation, pastures where the grass is thin and old cultivated fields are likely habitats for *Ephemerum*. The species grow intermixed and two or three species are not unusual in one collection. *Aphanorhegma* and *Nanomitrium* are frequent associates of *Ephemerum*.

The extremely large and few spore mother cells (SMC) of *Ephemerum* are very sensitive to pressure or to change in concentration of solution; and when the wall is broken, the cell contents disintegrate and disperse in the solution. Thus, they presented challenging material for developing a cytological technique. Neither the standard preparation technique (Steere, Anderson & Bryan, 1954) nor the method used for *Sphagnum* (Bryan, 1955) proved suitable for *Ephemerum*. Consequently the following method was developed: the plant to be studied is placed in a shallow, hemispherical, porcelain container, about 2 cm. in diameter, and covered with distilled water. With the dissecting microscope and extremely fine needles, the plant is freed of adhering particles of dirt, then transferred to absorbent paper and immediately into a container of 6:1 absolute alcohol and glacial acetic acid. When the studies were first started the procedure was to remove the capsule from the plant in water and transfer only the capsule to the fixative, but because of its smallness it was so frequently lost that almost

no successful mounts were obtained. Therefore, I found it best to remove the capsule from the seta only after the entire plant is immersed in the 6:1 fixative. The leafy plant and calyptra are then removed from the fixative, dipped in distilled water to rinse and placed in a drop of water on a clean slide, preparatory to being preserved as a permanent specimen in Hoyer's solution. The permanent specimen is later identified taxonomically whenever the cytological preparation of its SMC contains chromosome figures. By this means a taxonomic identification is made and recorded for each drawing of chromosomes or for each set of observations.

After the capsule is in the 6:1 fixative for about five minutes, a few drops of 3:1 fixative are added. After another five minutes the solution is drawn off, 3:1 fixative substituted and the capsule allowed to remain in the solution for about 6 to 96 hours. Then, on a clean glass slide the outer wall is removed from the capsule and transferred to the slide with the leaves. The spore sac is dissected open to free the SMC, which are then covered with acetic orcein and a cover slip. Warming the mount intensifies the stain in the chromosomes and clears the cytoplasm so that the mounts can be studied after about 15 minutes.

In the five taxa of *Ephemerum* investigated only one chromosome number was found: $n = 27$. In addition to the populations listed in TABLE 1 many others were studied, and all apparently possess the same number. Only those specimens which yielded very distinct and unquestionable figures are cited. Never more than six SMC from one capsule could be found intact and containing chromosomes, so that large numbers of capsules from each population had to be studied. In cytological mounts the dividing SMC are usually 50 to 70 μ, or almost twice as large as most SMC in the Bryales. The stained chromosomes are commonly scattered through a large volume of the cell. (Figures 1-5 were chosen in part to conserve space, and they reflect a rather infrequently found space relationship of the chromosomes.)

All the *Ephemerum* chromosome sets are similar. The bivalents are large, somewhat diffuse and stain very slowly. At first anaphase some chromosomes lag, but the distribution to the two poles appears to be equal. One or more chromosomes anticipate anaphase. A complete reorganization of the nucleus evidently occurs at interkinesis and is followed by a second division in which the individual chromosomes are very diffuse and difficult to distinguish.

Ephemerum serratum (Hedw.) Hampe is known chromosomally from only one collection. The specimen came from Stanford University campus and was very kindly sent to me by W. B. Schofield. As is typical of *E. serratum* from California, the leaves are not as serrate as those of the same species in eastern North America. There is, however, a series of intergrading forms from serrulate to spiny (Bryan & Anderson, 1957), so that the entire complex must be considered within one species.

FIG. 1-5. Bivalents at first meiotic metaphase in *Ephemerum*, $n = 27$; 1, *E. serratum*; 2, *E. cohaerens*; 3, *E. crassinervium*; 4, *E. spinulosum*; 5, *E. crassinervium* var. *texanum*. *Figures* 1-3 × 2170; *figures* 4 *and* 5 × 1450.

Ephemerum cohaerens (Hedw.) Hampe was collected during the winter of 1955-56 from two localities. The first, number 473, was collected by L. E. Anderson near Durham in a low, previously inundated field. While species of *Riccia* and *Ephemerum spinulosum* abounded in the area, *E. cohaerens* was scarce. These plants conformed closely to typical *E. cohaerens*. Quite different were the taxonomic characters of the leaves in the second collec-

tion, which I made in southern Florida. In these plants the leaves were larger and more flaccid and have a laxer areolation. A few other specimens approaching these characters are known from North Carolina, Tennessee and Louisiana. At first the specimens were thought to represent a new species, but because of the variability of members of this genus (Bryan & Anderson, 1957) and the paucity of specimens, we have called them *E. cohaerens*. No differences could be detected in the chromosome morphology or behavior in either of these collections, and the chromosomes appear to be very similar to those of *E. serratum*.

Ephemerum crassinervium (Schwaegr.) Hampe in North America consists of a wide variety of forms. Because the variability is so great the characters of the individual plants studied may be of importance. Specimens numbered 202 and 203 possess typical characters: lanceolate leaves toothed in the upper half, with large hyaline cells in the lower half becoming much smaller and papillose above. Fortunately, I was able to study chromosomes, also, of specimen 250, which closely resembles the European *E. sessile*. The leaf margins are only barely toothed or entire. The fourth specimen of *E. crassinervium*, 611, is a very unusual form. The exceedingly long leaves are composed of very small cells, and yet the moss is unquestionably *E. crassinervium*. No chromosome differences were detected.

Ephemerum crassinervium var. *texanum* (Grout) Bryan & Anderson has chromosomes which do not differ from others in the genus. The taxonomic characters of the cytological specimens are quite typical of the variety.

Ephemerum spinulosum Schimp. also varies widely morphologically but not cytologically. In my investigations three specimens from Columbus County, N. C., tend to have blunt spines, a character less common than the acute spines typical of the species; otherwise the plants have typically narrow linear leaves with lax areolation. Number 226A from Charlton County, Ga., has the leaf shape, spines and areolation of *E. spinulosum*, while the Québec material, 437, varies in the direction of *E. crassinervium*. The leaves are lanceolate and the spines blunt, but most spines are recurved 45° or more, and the leaves have a lax areolation, characters found in *E. spinulosum*.

NANOMITRIUM. Linked to *Ephemerum* through *N. megalosporum* and *N. wrightii*, *Nanomitrium* now is considered to have four North American representatives: *N. wrightii*, *N. megalo-*

sporum, *N. austinii*, and *N. synoicum*. They are found in *Ephemerum* habitats and even in *Ephemerum* colonies, but are evidently much rarer (Bryan & Anderson, 1957). Their geographic ranges are somewhat more southerly, although *Nanomitrium* has been collected as far north as Iowa and Maine.

Preparation of *Nanomitrium* SMC for chromosome studies also requires some adjustment of the standard technique, namely, the use of a short pre-fixation in 6:1 absolute alcohol and glacial acetic acid. The chromosomes stain quickly and deeply. They form compact division figures, yet with the chromosomes clearly separated from one another and standing out sharply against the uniform, unstained cytoplasm. Second division figures, as well as first, are plentiful, and the number and morphology of the chromosomes immediately obvious. The chromosomes of a set show considerable variation in gross morphology.

Two chromosome numbers were found in *Nanomitrium*: $n = 11$ for *N. austinii* (*fig.* 7 and 9) and $n = 22$ for *N. megalosporum* (*fig.* 6). It is this striking difference from *Ephemerum* and similarity to *Nanomitrium* that clarifies the formerly questionable generic position of *N. megalosporum*. Its systematic position will be discussed in a succeeding section.

Nanomitrium megalosporum (Aust.) Lindb. has bivalents and SMC which bear little resemblance to those of *Ephemerum*. Both the chromosomes and the SMC are smaller, although the SMC are intermediate in size between *Ephemerum* and *N. austinii*. Meiosis progresses regularly.

Nanomitrium austinii (Sull.) Lindb. also has meiosis proceeding without anomalies, except for the timing of one member of the set. This chromosome is outstandingly smaller and dissociates while the other 10 bivalents are still synapsed. After the chromosomes making up the small bivalent disjoin, they precede the others through anaphase and telophase but are evenly distributed in both divisions. Figures of second telophase show that each of the four sets in the SMC includes one very small chromosome (*fig.* 9). In addition, the 22 chromosomes in the somatic tissue of the sporophyte (*fig.* 8) include two very small chromosomes. Six North Carolina populations from the Coastal Plain and Piedmont were investigated. All except one, 610, revealed identical chromosomes situations: $n = 11$, $2n = 22$. The chromosomes of the non-conforming population resembled the others except for the lack of the very small chromosome. That this specimen does not differ morphologically from other specimens of *N. austinii* points up the

FIG. 6-9. *Nanomitrium* chromosomes. FIG. 6 and 7. Bivalents at first meiotic metaphase; 6, *N. megalosporum*, $n = 22$; 7. *N. austinii*, $n = 11$. 8. *N. austinii*, $2n = 22$. 9. *N. austinii* SMC with 4 sets of 11 chromosomes each at second telophase. *All figures* $\times$ 2170.

probably genetic inertness of the small chromosome. In many flowering plants the small chromosomes do not appear to be constant members of a chromosome set, while in the mosses most populations of a given species have identical chromosome complements.

The only marked difference between the sets of *N. megalosporum* and *N. austinii*, besides the doubled number, is the absence in the former of minute chromosomes. If *N. megalosporum* were an autoploid of *N. austinii*, two small chromosomes would be expected. Investigations of *N. synoicum* and *N. wrightii* may clarify the origin of the chromosome set in *N. megalosporum*. However, it seems that *N. megalosporum* is far removed from its congeners (Bryan & Anderson, 1957), and through evolution of its chromosomes, the sets have become quite different.

Systematic Position of Nanomitrium megalosporum. This species was described by Austin (1870) as *Micromitrium megalosporum*. A few years later Lindberg (1874) transferred it and its congeners, except *N. wrightii*, to his newly proposed *Nanomitrium*. (The name *Micromitrium* had previously been used in the Orthotrichaceae.) Salmon's studies of the genus (1899) resulted in his transferring *N. megalosporum* to *Ephemerum*, although he stated that the species is a link between the genera. Salmon stressed the importance of the double-layered, stomatal exothecium characteristic of *Ephemerum*. He was aware, though, of *megalosporum's* similarity to *Nanomitrium* in its small, persistent calyptra and non-apiculate capsule and the very lax areolation of its leaves. While a delimited operculum had been described for the species, Salmon could not verify its occurrence. Recent taxonomic studies (Bryan & Anderson, 1957) have verified these characters, including the formation in some capsules of a rudimentary operculum. Futhermore, we have observed that the areolation of the outer wall of the capsule resembles other *Nanomitrium* species more than *Ephemerum* and that the leaf areolation, too, is closer to *Nanomitrium*. In the present cytological investigations other similarities became obvious: the capsules at the time of meiosis are relatively much smaller in *Nanomitrium*, including *N. megalosporum*; likewise, the SMC are smaller, and, most obvious of all, the chromosome numbers of *N. austinii* and *N. megalosporum* form a polyploid series, 11 and 22, while the number in *Ephemerum* is 27. Thus, it appears that chromosome number in the taxonomy of *Nanomitrium megalosporum* is of high value, and it clearly establishes the generic affinities.

The lack of similarities in the cytology of *Nanomitrium* and *Ephemerum* has no parallel in known studies comparing various related moss genera (Bryan, 1956a, 1956b). The morphology is so similar that the generic line has been questioned and has resulted in the transfer of *N. wrightii* as well as *N. megalosporum* (Bryan & Anderson, 1957). Unquestionably *Ephemerum* and *Nanomitrium* are closely related.

Funariaceae

The Funariaceae consist of nine or ten genera including a series with little-differentiated sporophytes. The first of the series, *Physcomitrellopsis*, is cleistocarpous; *Physcomitrella* is functionally inoperculate, and in *Aphanorhegma* the capsule dehisces along an almost equatorial suture. *Aphanorhegma*, *Pyramidula* and *Physcomitrium* are aperistomate. Of these genera *Physcomitrella*, *Aphanorhegma*, *Pyramidula* and *Physcomitrium* are found in

North America, as well as other funariaceous genera, *Entosthodon* and *Funaria*.

The genera are distinguished primarily on sporophytic and calyptra characters, since the leaves are essentially identical. The characters are not strong and invariable, so that bryologists do not agree on the validity of some genera. For example, Lindberg (1879), Braithwaite (1887-1905), Brotherus (1924) and Dixon (1924) considered *Entosthodon* within *Funaria*. Dixon pointed out the affinity of *Physcomitrium* and *Funaria*, and says that they could be considered one genus except for the constant calyptra difference and the consistency in *Physcomitrium* of capsule form and structure. McClymont (1955a, 1955b) concluded that spore morphology unites *Physcomitrella*, *Aphanorhegma* and *Phycomitrium*, three genera often found growing together.

Among the most important contributions to our knowledge of relationships in the Funariaceae are the investigations of Wettstein and his co-workers (1923, 1924a, b, 1925, 1926, 1928, 1930, 1932, 1937, 1940, 1942; Wettstein & Straub, 1942; Schmidt, 1931; Barthelmess, 1938, 1941). They did not stress taxonomic conclusions, yet since they were able to produce intergeneric hybrids, much of their work cast strong doubt on generic boundaries. Few systematists have made use of these revealing data in evaluating Musci relationships. Andrews (1929), in a discussion of Wettstein's hybridizations, remarked that, from the point of view of natural relationships, *Funaria*, *Physcomitrium* and *Physcomitrella* are a single genus. Natural hybrids have long been known and have been reported among almost all the genera of Funariaceae, and Andrews (1918, 1942) believed that such hybrids also give evidence that *Aphanorhegma*, *Physcomitrella* and *Physcomitrium* constitute only one genus.

Cytological investigations have not kept up with genetic studies. Wettstein (1924b) reported chromosome numbers for three races of *Funaria hygrometrica*, $n = 14$, 28 and 56, and for *Physcomitrella patens*, $n = 16$. Schmidt thoroughly studied the chromosomes of *Physcomitrium pyriforme* in a natural population, $n = 36$, and experimentally produced plants with $n = 18$ and 72. Wettstein observed that mosses are very unfavorable cytological material with small, often clumped chromosomes. His feelings were anticipated by Heitz (1928), who said, "*Funaria* ist in zytologischer Hinsicht das schwierigste Laubmoos, welches mir begegnete."

In spite of the difficulties several workers have reported chromosome numbers in the family. Probably the earliest study was made by Beer (1903) on the chromosomes of *Funaria hygro-*

metrica. He reported four chromosomes but later (1906) revoked his earlier statement claiming the number to be much higher.[3] Chromosome numbers for several species of *Funaria* have been reported: *F. flavicans*, $n =$ ca. 10 (Beardsley, 1931); *F. californica*, $n = 24$ (Vaarama, 1953); *F. hygrometrica*, $n = 14$ (Wettstein, 1923, 1924a, b; Vaarama, 1953; Anderson & Crum, 1957), $n = 28$ (Wettstein, 1924b; Vaarama, 1950, 1955, 1956; Steere *et al.*, 1954), $n = 56$ (Wettstein, 1924b), $n =$ less than 20 but not 14 (Heitz, 1928); *F. mediterranea*, $n = 26$ (Griesinger, 1937); *F. muhlenbergii* var. *patula*, $n = 28$ (Steere *et al.*, 1954), and *F. microstoma* var. *obtusifolia*, $n = 28$ (Steere, 1954).

My cytological preparations of six species of five funariaceous genera were made by squash method described by Steere, Anderson and Bryan (1954). The SMC were fixed in 3:1 alcohol and glacial acetic acid for at least 24 hours before staining.

Aphanorhegma and Physcomitrella. The genus *Aphanorhegma* was established in 1848 by Sullivant for *A. serratum*. He considered this species an intermediate link between the cleistocarpous *Physcomitrella patens* BSG and the stegocarpous *Physcomitrium*. Later, Lindberg (1865) transferred *P. patens* to *Aphanorhegma*, a union favored also by Grout (1935). My cytological data do not argue against the union.

Aphanorhegma serratum (Hook. & Wils.) Sull. develops rapidly in the late summer and fall, probably within two months. Mature plants are found in North Carolina on open soil of paths and roadside ditches from October to January. The meiotic chromosomes of this species are irregular in shape, and in most SMC extremely coherent. Only after the preparation and study of dozens of capsules was the chromosome number established: 27 bivalents at first meiotic metaphase (*fig.* 10).

Physcomitrella patens BSG collections were sent to me from Washtenaw County, Michigan, by Robert Whitmire. The first, in the fall of 1954, yielded no definite chromosome count because the chromosomes were always found clumped near the center of the SMC to such an extent that not all of the individual chromosomes could be distinguished. About 22 bivalents was the tentative number assigned this collection, although the possibility of a higher number was not ruled out. Many SMC from the second collection

[3] In moss SMC at the completion of meiosis the four nuclei are very small and with inadequate optical equipment or superficial observation may be mistaken for four meiotic bivalents. No mosses have been found with only four chromosomes; five is the lowest number known.

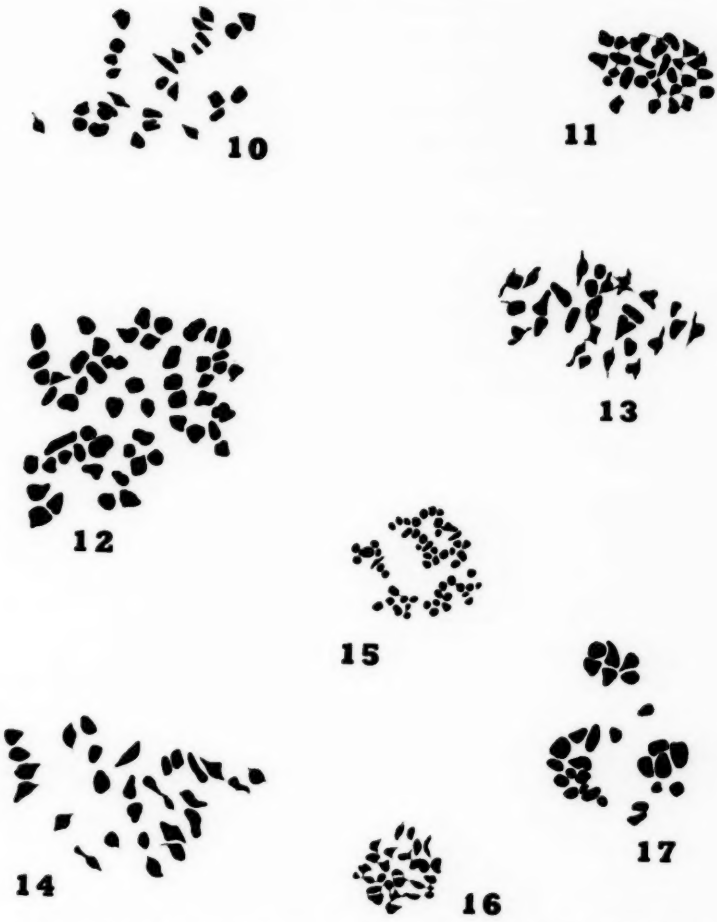

FIG. 10-17. Meiotic chromosomes of Funariaceae at first metaphase. 10. *Aphanorhegma serratum*, $n = 27$. 11. *Physcomitrella patens*, $n = 27$. 12. *Physcomitrium immersum*, $n = 54$. 13. *Physcomitrium pyriforme*, $n = 27$. 14. *Entosthodon drummondii*, $n = 27$. FIG. 15-17. *Funaria hygrometrica*; 15, "long-seta" type, $n = 56$; 16, "short-seta" type, $n = 28$; 17, "medium-seta" type, $n = 56$, the bivalents in secondary association. *All figures* $\times$ 2170.

made in October, 1955, at the same locality showed 27 bivalents quite clearly (*fig.* 11). The chromosomes, their stainability and meiotic figures in both *Physcomitrella* and *Aphanorhegma* appear to be identical.

Since the clumping of chromosomes is conspicuous in these species, and in the other funariaceous species, it is not surprising that lower numbers appear frequently enough at least to be considered the true count. The only earlier study of these species indicated the number $n = 16$ for *P. patens* (Wettstein, 1924b). Whether this number represents a chromosome race such as Wettstein (1930) and Schmidt (1931) have shown in *Physcomitrium pyriforme*, or whether it resulted from clumped chromosomes or a combination of both is impossible to determine. Probably, as in *Physcomitrium*, at least two chromosome races occur.

On the basis of morphology Britton (1895) concluded that *A. serratum* and *P. patens* are not congeners. She published drawings which emphasized the differences between the two: in *A. serratum* broader leaves, smaller calyptra and collenchymatous exothecium; in *P. patens* immersed stomates and some differentiation of an operculum, although less distinct than the lid of *A. serratum*. Andrews (1918) found no incipient differentiation of a lid and no immersed stomates.

Apparently both species hybridize naturally with *Physcomitrium turbinatum* (*pyriforme*) as the male parent, although the latter is a spring fruiting species. In Drummond's *Mosses of the Southern States*, no. 20, from the Columbia College Herbarium, Britton found *Physcomitrium*-like sporophytes on *A. serratum* gametophytes. Her figures of branched plants show near the base some typical *A. serratum* immersed capsules. Their collenchymatous exothecia are marked by an equatorial line of dehiscence. Exserted capsules occupy the extremities of the plants. Their more nearly apical lids, turbinate shape and parenchymatous exothecia are remarkably more like those found in *Physcomitrium turbinatum* than in any other species, and Britton considered them hybrids between *P. turbinatum* and *A. serratum*. It is of interest that the exserted capsules produced "imperfect" spores.

Andrews (1918) reported hybrid capsules on *P. patens*. The male parent was probably *Physcomitrium turbinatum* which grew in the same area with *Physcomitrella patens*, *Aphanorhegma serratum* and *Physcomitrium immersum*. Britton (1895) discussed a European hybrid. On *Physcomitrella patens* gametophytes she found two types of capsules on one plant: on the lower parts were typical *P. patens* capsules with mature spores, and on higher parts were capsules resembling *Physcomitrium*. Considering Britton's observations (1895) and his own, Andrews (1918) expressed the inclination to include *Aphanorhegma* within *Physcomitrium*.

Wettstein (1924b) found that some alleged natural hybrids agree in morphology with his experimentally produced hybrids.

But he felt that the natural production of hybrids is exceptional and occurs only under especially favorable conditions. His experimentally produced hybrids had *P. patens* as the maternal parent and as the paternal plant either *Funaria hygrometrica* or *Physcomitrium eurystomum*. As in Wettstein's other hybridizations, but apparently not in Britton's (1895) natural hybrids, the hybrids bore closer resemblance to the maternal parent. Wettstein reported (1932) hybrids between *Physcomitrella* and *Funaria* ($n = 14$) to have a chromosome number of $2n = 30$, and the polyploids derived by the regeneration to have $4n = 60$, $8n = 120$ and $16n = 240$. The hybrid capsules produced a few viable spores, but the resultant gametophytes did not develop beyond the protonematal stage. Reciprocal crosses with *Funaria* were unsuccessful but were possible with *Physcomitrium eurystomum*. Most of the spores of the cross *Physcomitrella patens* × *Physcomitrium eurystomum* and its reciprocal were sterile (Wettstein, 1924b, 1926). However, when the entire maternal and paternal genomes were occasionally separated in meiosis the spore tetrads consisted of two viable spores, those with maternal chromosomes, and two inviable, with paternal chromosomes in maternal cytoplasm. Wettstein (1932) emphasized the importance of cytoplasmic inheritance acting with chromosomal inheritance and showed that the more distantly related the parents, morphologically speaking, the greater the inviability of the spores.

Wettstein's data show that *Physcomitrella patens* hybridizes with *Physcomitrium eurystomum* somewhat more successfully than with *Funaria*, although the hybrids of both are incapable of reproduction as hybrids. The great reduction of viable spores is evidence that barriers exist between these taxa. However, since the *Physcomitrella* genomes will unit with either of the others, and sporophytes develop, congeneric status must at least be considered. An extension of Wettstein's *Physcomitrella patens* experiments to other species of *Physcomitrium* and *Funaria* might elucidate the degree of separation to a point of greater certainty. The success of *P. patens* crosses with *Aphanorhegma serratum* is unknown. Yet with the weak morphological distinctions and very similar chromosomes the relationship is presumed to be close and the production of viable spores and successful F_1 gametophytes is more likely than with *Physcomitrium* and *Funaria*. Experimental data for hybridization of these two closely related entities is needed to establish their relationship as congeneric or possibly as conspecific.

Physcomitrium. *Physcomitrium immersum* Sull., a member of the subgenus Cryptopyxis, produces its spores in the autumn. In the fall of 1955 H. A. Crum sent a Québec collection of fruiting

P. immersum in good cytological condition. The specimen was mixed with *A. serratum*, from which it is distinguished by a smaller lid, an annulus and parenchymatous exothecial cells.

The chromosomes of the species are typical of the family: they clump strongly and tend to be very cohesive. The determination of an exact number proved difficult, although it was always obvious that more than the expected 27 or 28 were present. Fifty-four bivalents (*fig.* 12) were finally determined as the maximum number. The meiotic chromosomes do not vary much in size and shape.

Physcomitrium immersum has also been reported to hybridize in nature. On a typical *P. immersum* gametophyte Andrews (1942) found capsules with characteristics of both *P. turbinatum* and *P. immersum*. He had previously (1929) said that *Funaria*, *Physcomitrium* and *Physcomitrella* are "doubtless but one from the point of view of natural relationship." Wettstein's experiments did not include this species.

Physcomitrium pyriforme Brid. from the Duke Gardens at Duke University proved to have a chromosome number at variance with previously known numbers. Subsequent collections from two localities in the North Carolina coastal plain showed identical chromosome pictures. All populations, like *A. serratum* and *Physcomitrella patens*, have 27 bivalents at first metaphase (*fig.* 13). These chromosomes, too, are somewhat irregular in shape and frequently found *en masse*.

The cytology of *P. pyriforme*, of which *P. turbinatum* Mx. has been called the North American counterpart, was studied by Schmidt (1931). He studied not only a wild race but also several derivative races obtained by regeneration and crossing. His cytological observations are prefaced by remarks similar in tone to those of Wettstein and Heitz: he described the cytology of *Physcomitrium* and most mosses as unfavorable, with the chromosome number high and the size small, and with a tendency for chromosomes to clump.

In the original material, *Pi*, Schmidt found in prophase $2n = 72$ chromosomes. Later in the division only part of the chromosomes were synapsed, and an exact count was difficult, but from antheridial tissue he obtained counts of $n = 36$. Some tripolar spindles were seen. Meiosis in the bivalent race, Pi^2, regenerated from the wild race, was highly irregular so that no figures of the expected 144 (72 bivalents) were found. Schmidt's illustration of early meiosis shows groups of 4, 3 and 2 chromosomes, as well as unpaired chromosomes. Frequently 3-pole spindles were seen.

The spores resulting from this division were mostly inviable; however, some spores did germinate, and gametophytes developed. One such plant, originally obtained experimentally by Wettstein (1930) and called $Pi^2_{F_1}154$, Schmidt discovered, had a haploid set of 18 chromosomes. Another had a haploid set of 24 ± 1. Wettstein and Schmidt worked extensively with the hemiplont, Pi^2_F 154, comparing its characteristics with those of the original haplont, $n = 36$ race, and with a diplohemiplont (regenerated from the sporophyte of the hemiplont). They found that the diplohemiplont (with two duplicate sets of 18 chromosomes) differed from the haplont ($n = 36$). Wettstein concluded that the haplont contained the 18 chromosomes of the hemiplont plus 18 chromosomes, some or all differing from the hemiplont's complement. The diplohemiplont showed many *gigas* characters, but the haplont was not a *gigas*-type of the hemiplont. In some characters, however, the haplont exceeded the hemiplont, and Wettstein considered that the tendency for these characters would be the same in the second set of chromosomes as in the 18 of the hemiplont, giving a *gigas* effect. In comparing the diplohemiplont, $n = 36$, and the *bivalens* race, the former composed of 2 hemiplont genomes and the latter of 2 hemiplont plus 2 *Restgenome*, Wettstein found that the *bivalens* race exceeded the diplohemiplont.

Some of the hybrids of *P. pyriforme* reported to occur in nature have already been discussed. The experimental hybridizations carried out by Wettstein and his co-workers centered on reciprocal crosses with *Funaria hygrometrica*. Considerable sterility was detected. The viable spores produced numerous matriclinous plants and some with individual paternal-like characters, but no patriclinous individuals were seen. Wettstein (1928) attributed sterility and absence of paternal-like gametophytes to an incompatility of many genes of the paternal parent and the maternal cytoplasm. Thus, the recognition of *Physcomitrium* as distinct from *Funaria* could be argued, but the production of some viable spores and F_1 progeny points to congeneric status.

The wide variation of *P. pyriforme* has been surveyed by Crum and Anderson (1955) as a part of their preliminary taxonomic studies in the Funariaceae. They found extraordinary variability in American plants, correlating in no way with geographic distribution, and they suggested that this variability is evidence for considerable polyploidy "or other cytological plasticity" within the species. These observations coupled with the discovery of the 27 chromosome race for a species also capable of existence with 18, 36 or 72 chromosomes make further cytological studies imperative. Were the chromosome number in all North American popu-

lations to be found different from that of European populations, we would have evidence for the retention of *P. turbinatum*, which was rejected by Crum and Anderson (1955). They believe the range of variation of the North American material lies within that of the European *P. pyriforme*. On the other hand, if the chromosome number is found to vary in American and European material no credence could be placed on chromosome number, unless a correlation was found between chromosome races and morphological variation in taxonomic characters. In view of Schmidt's and Wettstein's analyses of the *Physcomitrium* complement, the existence of chromosome races in wild populations seems likely.

ENTOSTHODON. Many bryologists do not segregate *Entosthodon* from *Funaria* because of the weakness and inconsistency of the distinguishing characters. The morphological similarity to *Physcomitrium* also is obvious, and the cytological observations confirm the affinity. The representative used in this study is *Entosthodon drummondii* Sull., a common species in the North Carolina coastal plain. In early spring it fruits abundantly. The collection from which this study was made came from a sandhill in Harnett County. Twenty-seven bivalents make up the meiotic complement, and these chromosomes, too, form configurations difficult to interpret. Only an occasional cell has the chromosomes spread out as much as is shown in *figure* 14.

Only one hybridization is known for *Entosthodon*. Wettstein (1928) reported crosses between *E. fascicularis* and *Funaria hygrometrica*. He obtained only sterile spores, which might indicate true generic status for *Entosthodon*. Still the paucity of genetic data and the similarity in chromosome behavior leave the question open.

FUNARIA. The variety of numbers attributed to *Funaria* is not surprising for several reasons. *First*, because of its small chromosomes and meiotic difficulties superior optical equipment is needed. The lack of such equipment could easily be responsible for some discrepancies of the earlier reports. The meiotic disturbances themselves have doubtless contributed to the confusion. *Finally*, on the basis of Wettstein's experiments both with *Physcomitrium* (1930) and *Funaria* (1924b), we have reason to believe that *Funaria* species can be supported by more than one number of chromosomes.

L. E. Anderson collected two populations of maturing *Funaria hygrometrica* Hedw. His first collection was a population characterized by unusually short setae. These plants had a chromo-

some number of $n = 28$ (*fig.* 16). The second population, characterized by unusually long setae, had $n = 56$ (*fig.* 15). One more colony was studied cytologically and found to have probably 56 bivalents, but they appeared mostly in various degrees of secondary association. *Figure* 17 shows the maximum extent of association seen: all bivalents in pairs. These plants possess setae intermediate in length.

As Wettstein has pointed out (1924b), meiosis in *Funaria* is abnormal, and chromosome counts can be made only after much study of the early stages. In most cells some of the chromosomes do not synapse, and the metaphase plates usually contain bivalents and unpaired chromosomes clumped together or appearing to be very cohesive. Another difference besides chromosome number was found in *Funaria:* the chromosomes are remarkably smaller than in any other funariaceous genus.

Wettstein used *Funaria hygrometrica* extensively for regeneration and hybridization experiments. In comparing Wettstein's experimental $n = 28$ race, Vaarama (1955) found morphological differences in a wild race with $n = 28$. Wettstein (1928) analyzed crosses of different strains and demonstrated that the offspring showed Mendelian inheritance. Also he (1930) crossed this species with other species of *Funaria,* especially *F. mediterranea* and found that the F_1 hybrids were intermediate, but again tended to resemble the maternal parent. Even after several generations the maternal effect was not lost. Furthermore, he built up by regeneration and backcrossing the number of paternal genomes in the maternal cytoplasm, but still did not lose the matricliny. Crosses with *Physcomitrium pyriforme* and *Physcomitrella patens* had greatly reduced fertility. The latter produced capsules and viable spores only when used as the maternal parent (1924b), and the F_1 gametophytes did not develop beyond the protonematal stage.

Wettstein's work shows that differences in chromosome numbers of *Funaria hygrometrica* and other genera used for hybridization apparently have no great effect on the results of the crosses. The chromosome sets are united at fertilization in the maternal cytoplasm, and the mitotic divisions proceed with sufficient regularity for development of the sporophyte. At meiosis the irregular divisions result in many sterile and a few viable spores. The latter arise evidently by the chance segregation of chromosomes compatible with the maternal cytoplasm. However, the chromosome sets are not totally independent. Wettstein has shown that the genes are able to combine freely; therefore, within the Funariaceae much of the genic material must be held in common, an indication of close relationships.

RELATIONSHIP OF THE EPHEMERACEAE AND FUNARIACEAE

Until the first decade of this century the functionally indehiscent mosses (including most of the mosses of this study) were usually considered to constitute a small "natural" group. Few early bryologists openly regarded these forms as related to the more complex operculate groups, although as early as 1823 Nees von Esenbeck, Hornschuch and Sturm had expressed this concept. From that time allusions to the diverse relationships of the dwarf mosses became increasingly frequent, and by 1880 most authors recognized that the "Aperistomati" or "Cleistocarpi" was an artificial, although convenient category. Several works retaining this group were published later, however, and even in 1923 (Lorch) the division was used.

The earliest classification of the functionally indehiscent Funariales was in the genus *Phascum* L. Prior to the publication of Hedwig's *Species Muscorum*, von Schreber (1770) described *P. serratum*, now *Ephemerum serratum* in *De Phasco Observationes*. The genus *Phascum*, as circumscribed by Hedwig, included all the inoperculate mosses known to him. In his generic key he first separated *Phascum* by "Sporangio astomo," and in the genus he recognized 11 species, including (now) *Aphanorhegma patens*, as well as *Ephemerum serratum E. cohaerens*. At the end of the eighteenth century Bridel began publishing his *Muscologia Recentiorum*, in which he divided the mosses into four classes. The first class was the Aperistomati in which he placed the genus *Phascum*. His species are mostly the same as those recognized by Hedwig. By 1826 Bridel's concept of moss classification was radically altered. In this year and the next he published the *Bryologia Universa*, in which he distributed the inoperculate groups among three of six classes in Section I, Musci calyptrati, operculati, olocarpi. The first class, Evaginulati s. Cladocarpi, consisted of two orders, the Astomi for *Archidium* and the Gymnostomi for *Sphagnum*. Class II, Vaginulati. Acrocarpi, included *Phascum* (30 species) with *Physedium splachnoides* [*Pottia splachnoides* (Hornsch.) Broth.] two species of *Voitia* and one of *Saproma* (*Bruchia vogesiaca* Schwaegr.).

Bridel's distribution of the inoperculates was preceded by the *Bryologia Germanica* (Nees von Esenbeck *et al.*, 1823-31). This work marks the beginning of attempts to incorporate the inoperculates with mosses of similar gametophytic characters and embryogeny, yet with more complex mature sporophytes. Fürnrohr (1829), too, presented a classification without a special section for the cleistocarpous and functionally cleistocarpous forms. In an early work Hampe (1837) established *Ephemerum* (including

Aphanorhegma patens and *Acaulon*) and placed it in the Funarieae. He yielded, however, to considerable criticism and thereafter recognized the "Cleistocarpi."

Beyond acknowledging the affinity of *Ephemerum* and *Physcomitrella*, further cognizance of the relationship of these genera to the higher Funariaceae developed slowly. Wilson (1855) separated *Ephemerum* and *Physcomitrella*. He included the former and *Acaulon* in one section and recognized *Physcomitrella* and *Aphanorhegma serratum* as allied to *Funaria*. The similarity of *Ephemerum* to *Phascum*, *Acaulon*, *Astomum* and *Barbula* prevented unanimity in proposed systems of classification. The outstanding bryologists Lindberg (1879) and Braithwaite (1887-1905) regarded *Ephemerum* as a member of the Tortulaceae, and Braithwaite assigned *Nanomitrium* and *Physcomitrella* to the Funariaceae. Kindberg (1897) placed *Ephemerum* and *Nanomitrium* in the Bruchiaceae. Mitten (1851), Jaeger (1869) and Milde (1869) published classifications which showed the relationships of *Ephemerum*, *Physcomitrella* and *Aphanorhegma* to *Pyramidula*, *Physcomitrium*, *Entosthodon* and *Funaria*. With increasing frequency references appeared pointing to the appropriateness of discarding the cleistocarpous division.

Since 1900 most of the systematic treatments of the Musci, based on morphological studies, have reflected the conviction that *Ephemerum*, *Nanomitriopsis* and *Nanomitrium* are closely related to *Physcomitrella*, *Aphanorhegma* and other Funariaceae. The accumulated cytological data for these genera and others with which affinities were claimed now offer further evidence for relationship of the Ephemeraceae and the Funariaceae.

The lack of variation in chromosome numbers found in the five *Ephemerum* species, *Aphanorhegma serratum*, *Physcomitrella patens*, *Physcomitrium immersum*, *Physcomitrium pyriforme* and *Entosthodon drummondii* can be considered corroborating evidence for the relationship of these members of the Ephemeraceae and Funariaceae. Yet, beyond the identical numbers the similarities are not strong: the standard preparation technique was wholly inadequate for *Ephemerum* and *Nanomitrium*, while little alteration was needed in the funariaceous cell mounts. Since different preparation schedules were used for material of each family the resultant preparations cannot be compared but should be considered. In *Ephemerum* and *Nanomitrium* the very large chromosomes are distinct compact units which stain somewhat slowly; the six species of the Funariaceae have very cohesive, amorphous-appearing chromosomes which are also slow to take up the stain.

In order to evaluate the chromosome characters as indicative of

relationship we must compare also the same characters in other groups possibly related to the Ephemeraceae: in the Dicranaceae seven species of the cleistocarpous genus *Bruchia* have chromosome number of $n = 14$, $n = 15$ and $n = 28$ (Bryan, 1956b). In chromosome stainability and meitoic characteristics they resemble the Ephemeraceae and Funariaceae, although the morphology of the chromosomes is not at all similar. None of the 40 dicranaceous species known cytologically has 27 chromosomes. In the Pottiaceae the simpler genera, *Astomum*, *Acaulon* and *Phascum*, have chromosome numbers of $n = 13$ or $n = 26$ (Bryan, 1956a). No clumping occurs, the chromosomes usually stain without difficulty and the morphology is quite different from that of the Funariaceae and Ephemeraceae chromosomes. Of the 41 pottiaceous species for which chromosomes are known none has $n = 11$ or 27. Thus, despite the inexplicable dissimilarities of *Nanomitrium* and *Ephemerum* cytology, the cytological evidence points more strongly to the relationship of Ephemeraceae to Funariaceae than to any other families.

At the family level relationships are apparently so distant that characteristics of cytological reaction to fixation and staining and chromosome numbers do not show strong and conclusive resemblances, and only exceptionally are intraspecific variations reflected in cytological conditions. In these investigations in the Funariales, as those in the Ditrichaceae, Dicranaceae and Pottiaceae, the cytological data have greatest value in systematic problems at the generic level.

Literature Cited

Anderson, L. E. & H. A. Crum. 1957. Chromosome studies of Canadian mosses. Bull. Nat. Mus. Canada (*in press*).

Andrews, A. L. 1918. A new hybrid in *Physcomitrium*. Torreya 18: 52-54.

———. 1929. Review. Fritz v. Wettstein, Morphologie und Physiologie des Formwechsels der Moose auf genetischer Grundlage, II. Leipzig. 1928. The Bryologist 32: 14-15.

———. 1942. Taxonomic notes. II. Another natural hybrid in the Funariaceae. *Ibid.* 45: 176-178.

Austin, C. F. 1870. Musci Appalachiani. Tickets of specimens . . . 92 pp. Closter, N. J.

Barthelmess, A. 1938, 1941. Mutationsversuche mit einem Laubmoose *Physcomitrium piriforme*. Zeitschr. f. indukt. Abst. Vererb. 74: 479-518; 79: 153-170.

Beardsley, M. L. 1931. The cytology of *Funaria flavicans* Michx. with special reference to fertilization. Ann. Missouri Bot. Gard. 18: 509-536.

Beer, R. 1903. The chromosomes of *Funaria hygrometrica*. New Phytol. 2: 166-167.

———. 1906. On the development of the spores of *Riccia glauca*. Ann. Bot. 20: 275-291.

BLOMQUIST, H. L. 1931. Genetics of mosses. Jour. Elisha Mitchell Sci. Soc. 46: 267-275.

BRAITHWAITE, R. 1887-1905. The British Moss Flora. *3 vol.* Illus. *London.*

BRIDEL, S. E. 1761-1828. Muscologia Recentiorum . . . *2 vol. Illus.* Goethe & Parisiis.

BRITTON, ELIZABETH G. 1895. Contributions to American bryology—IX. Bull. Torrey Bot. Club 22: 62-68. *Pl.* 229-231.

BROTHERUS, V. F. 1924-25. Andreaeales: Bryales. *In* Engler & Prantl, Die natürlichen Pflanzenfamilien. *Vol.* 10-11. *Illus.* Leipzig.

BRYAN, VIRGINIA S. 1955. Chromosome studies in the genus *Sphagnum.* THE BRYOLOGIST 58: 16-39.

———. 1956a. Cytological and taxonomic studies of some species of *Astomum, Acaulon* and *Phascum. Ibid.* 59: 118-129.

———. 1956b. Chromosomes and systematic position of the inoperculate mosses, *Fleuridium* and *Bruchia.* Amer. Jour. Bot. 43: 460-468.

——— & L. E. ANDERSON. 1957. The Ephemeraceae in North America. THE BRYOLOGIST 60: 67-102. *Fig.* 1-57.

CRUM, H. A. & L. E. ANDERSON. 1955. Taxonomic studies in the Funariaceae. THE BRYOLOGIST 58: 1-15. *Fig.* 1-19.

DIXON, H. N. 1924. The Student's Handbook of British Mosses. *Ed. 3.* xlvi + 582 *pp. Pl.* 1-63. Eastbourne.

FÜRNKOHR, A. E. 1829. Sam. El. a Bridel-Brideri . . . Bryologia Universa. Flora 12 (Ergänzungsbl. 2): 1-60.

GRIESINGER, R. 1937. Über hypo- und hyperdiploide Formen von *Petunia, Hyoscyamus, Lamium* und einige andere Chromosomenzahlungen. Ber. Deutsch. bot. Ges. 55: 557-571.

GROUT, A. J. 1935. Moss Flora of North America. Vol. 2, pp. 67-89. Newfane, Vt.

HAMPE, E. 1837. Musci frondosi Germaniae ad methodum naturalem dispositi. Flora 20: 273-287.

HEDWIG, J. 1801. Species Muscorum Frondosorum . . . vi + 353 *pp. Pl.* 1-77. Leipzig.

HEITZ, E. 1928. Das Heterochromatin der Moose. I. Jahrb. Wiss. Bot. 69: 762-818.

JAEGER, A. 1869. Übersicht über die cleistocarpischen Moose. Ber. St. Gall. Nat. Ges. 1868-69: 62-114.

KINDBERG, N. C. 1896-97. European and Northamerican Bryineae (Mosses) described by N. C. Kindberg. *Parts* 1, 2. Linköping, Sweden.

LINDBERG, S. O. 1865. Uppställning af familjen Funariaceae. Öfv. K. Sv. Vet.-Akad. Förh. 21: 589-608.

———. 1874. Manipulus muscorum secundus. Notis. Sällsk. Fauna et Flora Fenn. Förh. N. S. 13: 351-418.

———. 1879. Musci Scandinavici in systemate novo naturali dispositi. 50 *pp.* Uppsala.

LORCH, W. 1923. Die Laubmoose. *Ed. 2.* 6 + (16) + 236 *pp.* 273 *fig.* Berlin.

MCCLYMONT, J. W. 1955a. Spores of the Musci. Ph.D. dissertation, University of Michigan. Univ. Microfilms no. 11,317. Ann Arbor.

———. 1955b. Spore studies in the Musci, with special reference to the genus *Bruchia.* THE BRYOLOGIST 58: 287-306.

MILDE, J. 1869. Bryologia Silesiaca . . . ix + 410 *pp.* Leipzig.

MITTEN, W. 1851. Some remarks on mosses, with a new arrangement of their genera. Ann. and Mag. Nat. Hist. *2*, 8: 51-59.

NEES VON ESENBECK, C. G., F. HORNSCHUCH & J. STURM. 1823-31. Bryologia Germanica . . . *Theile* 1 *and* 2 (*Abt.* 1-2). 43 *pl.* Nürnberg & Leipzig.

SALMON, E. S. 1899. Notes on the genus *Nanomitrium* Lindberg. Jour. Linn. Soc. London, Bot. 34(236): 163-170. *Pl.* 5.

SCHMIDT, M. 1931. Experimentelle Analyse der Genom und Plasmonwirkung bei Moosen. Zeitschr. f. indukt. Abst. Vererb. 57: 306-342.

SCHREBER, J. C. D. VON. 1770. De Phasco Observationes . . . *22 pp. 2 pl.* Leipzig.

STEERE, W. C. 1954. Chromosome number and behavior in arctic mosses. Bot. Gaz. 116: 93-133.

———, L. E. ANDERSON & VIRGINIA S. BRYAN. 1954. Chromosome studies on California mosses. Mem. Torrey Bot. Club 20(4): 1-75.

SULLIVANT, W. S. 1848. Musci and Hepaticae . . . contributed to the first edition of Gray's Manual of Botany. *Pp.* 641-696. *Pl.* 1-8. New York.

VAARAMA, A. 1950. Studies on chromosome numbers and certain meiotic features of several Finnish moss species. Bot. Notis. 1950: 239-256.

———. 1953. Some chromosome numbers of Californian and Finnish moss species. THE BRYOLOGIST 56: 169-177.

———. 1955. On the characteristics of the spontaneous bivalent race of *Funaria hygrometrica*. Arch. Soc. Zool. Bot. Fenn. "Vanamo" 9: 395-400.

———. 1956. A contribution to the cytology of some mosses of the British Isles. Irish Nat. Jour. 12: 1-11.

WETTSTEIN, F. VON. 1923, 1924a. Kreuzungsversuche mit multiploiden Moosrassen. Biol. Zentralbl. 43: 71-82; 44: 145-168.

———. 1924b. Morphologie und Physiologie des Formwechsels der Moose auf genetischer Grundlage. I. Zeitschr. f. indukt. Abst. Vererb. 33: 1-236, 253-257.

———. 1925. Genetische Untersuchungen an Moosen. Biblio. Genetica 1: 1-38.

———. 1926, 1930. Über plasmatische Vererbung, sowie Plasma- und Gen-Wirkung. Nachr. Ges. Wiss. Göttingen Math.-Phys. Kl. 1926: 250-281; 2: 109-118.

———. 1928. Morphologie und Physiologie des Formwechsels der Moose. II. Biblio. Genetica 10: 1-216.

———. 1932. Genetik. *In* Verdoorn's Manual of Bryology. *Pp.* 233-272. The Hague.

———. 1937. Experimentelle Untersuchungen zum Artbildungsproblem. Zeitschr. f. indukt. Abst. Vererb. 74: 34-53.

———. 1940. Experimentelle Untersuchungen zum Artbildungsproblem. Ber. Deutsch. bot. Ges. 58: 374-388.

———. 1942. Über einige Beobachtungen und experimentelle Befunde bei Laubmoosen. *Ibid.* 60: 394-414.

——— & J. STRAUB. 1942. Experimentelle Untersuchungen zum Artbildungsproblem. Zeitschr. f. indukt. Abst. Vererb. 80: 271-280.

WILSON, W. 1855. Bryologia Britannica . . . xx + 445 *pp. Pl.* 1-61. London.

TAXONOMIC NOTES. XIII. THE GENUS CAMPYLIUM

A. LeRoy Andrews[1]

Among the families of the Hypnobryales the Amblystegiaceae of Fleischer and Brotherus (subfamily Amblystegieae of Grout) is one of the more problematical ones, problematical in its separation from the others and in its division into genera and species. Fleischer's idea that it originated from the Thuidiaceae is appealing enough; certainly its close relationship with the Leskeaceae-Thuidiaceae seems undeniable, but in some instances connections with the Hypnaceae in the narrower sense of the latter are not easy to disentangle. The genus *Amblystegium*, separated out of the Linnaean *Hypnum* in the *Bryologia Europaea* (1853), has subsequently been further subdivided into genera, which though apparently often justified, sometimes pass into one another by very close transitions. Among these genera is *Campylium*, distinguished by more elongated leaf cells. The name *Campylium* was given by Sullivant (1856) to a subgenus (or section) of *Hypnum*. It was promoted to generic status by Mitten in 1869. Though the generic name was, according to Limpricht, antedated by a phanerogamic genus *Campylia* Sweet 1820, it is not, according to present nomenclatural rules, invalidated thereby any more than for example *Pleurozium* is invalidated by *Pleurozia*.

When Lindberg published his remarkable Musci Scandinavici in 1879, though he conceived of *Amblystegium* in a very broad sense, he accepted the generic separation of *Campylium*, but in a narrower sense than that of Sullivant and Schimper. As Mitten had mentioned only one of the species of Sullivant's subgenus, namely *C. hispidulum*, it should constitute the type species of the genus. It was so recognized by Lindberg who associated with it only a variety *Sommerfeltii*, by many regarded as a separate species, and another species *C. Halleri*. These three taxa have for the most part been accepted by later bryologists as a closely related group well set off from other species. I see no reason to disagree with this and would then accept the genus *Campylium* in this limited sense. But many bryologists still include in *Campylium* the other species placed there by Sullivant, namely those grouped about *C. chrysophyllum*. For this other group Loeske would employ the name *Chrysohypnum* (1910, p. 195). This name is said to have been first used subgenerically by Hampe.[2] It was first employed

[1] 409 Mitchell St., Ithaca, N. Y.

[2] Confirmation of this is rendered difficult by wrong page citation, passed on mechanically from one reference to another; correct is Bot. Zeit. 10: 71 (not 7). 23 Jan. 1852. It is contained in an interesting letter addressed to Karl Müller, author of the newly completed *Synopsis Muscorum*, suggesting

in generic sense by Roth (1899; printed as *Chryso Hypnum* on p. 7). But Roth's species are *Sommerfeltii, hispidulum* and *Halleri*, that is, precisely the three belonging to *Campylium*, so that the name should be dropped as a synonym despite later emendation. Mönkemeyer (1927) employed it to cover both groups instead of the older and more generally employed *Campylium*, for what reason I do not know. The only name that seems available for the group of species around *C. chrysophyllum* is the sectional name *Campyliadelphus* of Lindberg, which could easily be made generic, unless one were to employ *Leptodictyum* (Schimp.) Warnst., which Loeske does in reverse, including *L. riparium* in *Chrysohypnum*. I am not sure that I am convinced by Loeske's reasoning on this point, but will not discuss the matter here.

A peculiar and seemingly unnecessary break in natural relationships is represented by the introduction of *Campylophyllum*. Schimper is in the first place responsible for this for in the second edition of his *Sypnopsis* (1876, p. 721) he has *Hypnum*, Subgenus 1, *Campylophyllum*, with *H. Halleri* alone; following it under subgenus 2, *Campylium*, with *H. Sommerfeltii* and the species grouped about *H. chrysophyllum*. As genus, *Campylophyllum* is credited to Fleischer, which should technically be Fleischer *ex* Loeske, as its publication is in an article by Loeske, "Die Moose des Arlberggebietes," (1908) where there is listed "*Campylophyllum Halleri* (Swartz) Max Fleischer *in litt.*" This has unfortunately led Brotherus in his second edition of the Musci in Engler and Prantl (1925 p. 335 ff.) to include *C. hispidulum* under *Campylium*, Section *Campylophyllum* and *C. Halleri* under genus *Campylophyllum*. Loeske on the other hand could not have taken Fleischer's genus too seriously for a few years after its publication he recognized in his already mentioned work of 1910 (p. 195) the three taxa of *Campylium* as constituting a definite group, closely related to each other and sharply set off from the species around *C. chrysophyllum*, for which latter he used the name *Chrysohypnum* (Hpe.) G. Roth.

While accepting the three unit *Campylium* of Lindberg I would further differ from the usual present conception in disassociating it entirely from the Amblystegiaceae and placing it in the Hypnaceae in the latter's present narrower sense. This idea is, however,

a more systematic classification of the innumerable species of *Hypnum*. Hampe would divide the genus into a number of groups (*Gruppen*), one of them *Chrysohypnum*, itself a rather extensive one with five tribes, one of the latter *Chrysophylla* with species *chrysophyllum, Halleri*, etc.

not original as Mitten placed his *Campylium* just before *Ctenidium* in the Stereodonteae. What is now called *Hypnum* was *Stereodon* to Mitten. Lindberg also, who had the same conception of *Stereodon*, included *Campylium*, but not his *Amblystegium*, in the Stereodonteae of the Stereodontaceae. In this connection it is to be noted that several of the small genera formerly included in *Amblystegium* have similarly been removed by some bryologists to the present Hypnaceae. For example Grout (1932) has done so with *Amblystegiella* Loeske, and I think correctly. Lindberg had already *A. confervoides*, but not the other two European species, in his *Stereodon*. *Homomallium* (Schimp.) Loeske is now generally accepted as a member of the Hypnaceae in its narrower sense. Here again Lindberg already had its European species, its type, in his *Stereodon*.

As to the three familiar units, I will first discuss them as if they were three different species and leave final conclusions until after the discussion.

1. CAMPYLIUM HALLERI (Swartz) Lindberg. This is the oldest of the three taxa as it was distinguished and described, but without binomial designation, already in 1768 by the eminent Swiss scientist and poet Albrecht von Haller. It was then given his name as *Hypnum Halleri* in 1781 by Swartz. The specific name has persisted to the present without change or accumulation of synonyms apart from the apparently unnecessary *Hypnum Macounii* Kindb. (1890). It is definitely a limestone moss and rather easily recognized by small size, brownish-yellow color, leaves strongly recurved, serrulate and sharply acuminate. Like the other species of the genus it is autoicous and generally fruiting. It is well known through the mountainous regions of Europe. I have myself collected it from four localities in Switzerland where limestone is abundant and one locality in Norway where limestone is scarce. In North America the species is regarded as a rarity and, as Grout says, is perhaps not as characteristically developed as in Europe. Its areas seem to be the Rocky Mountain region of the West and Labrador, Newfoundland and a few other localities of the Northeast. I cannot see but that the collection by R. S. Williams at Nyack, N. Y., in 1894 was correctly named, though it is not included by Grout. (Williams was familiar with the species from Montana.) The same is true of a specimen collected recently by Brother Fabius at Mt. Ste.-Anne in Quebec and an earlier "Gaspé" collection (without more precise locality data, made by John Macoun in 1882 but wrongly identified as *Hypnum hispidulum*.

2. CAMPYLIUM HISPIDULUM (Bridel) Mitten. The type of this species was from Pennsylvania, and its main distribution is in

the eastern United States where it is familiar to every bryologist. It is nearer to the last species than generally supposed and if occurring in the same regions could easily be confused with it. It is normally distinguished as green rather than brownish or yellowish, more prostrate and less pinnate as to its branching, the leaves less crowded, squarrose but not recurved, longer acuminate and more strongly serrate, especially in basal part. It is more tolerant as to substratum, even growing on rotten wood. Its leaf cells are generally thinner-walled and hardly as narrow and elongated. One character I have noted that seems not to be mentioned in technical descriptions is the tendency of the leaf cells to project at their upper ends on the dorsal surface, giving a slightly papillose effect. The amount of this papillosity is variable; it is especially prominent on the lower convex part of the leaf, where seen in profile it partly accounts for so-called serration of the lower part or all of the leaf. Though not mentioned in descriptions this character seems to be indicated in the drawing of *Campylium hispidulum* var. *Sommerfeltii* done by Joseph Pohl in Berlin for Brotherus' *Laubmoose Fennoskandias* (1923, p. 461), where on the same page *Ctenidium molluscum* shows the same feature indicated in the same way. Lindberg places *Campylium* next to *Ctenidium* in relationship, and I would refer to my notes (1954, p. 259) on this character as marking a group of genera of the Hypnaceae. This feature is to my mind one of the strong reasons for putting *Campylium* in the present Hypnaceae. It should be stated that the character is prominent only in *hispidulum*, reduced or lacking in *Sommerfeltii* and apparently lacking entirely in *Halleri*. Though the microscope reveals minor variation in some particulars, the species *hispidulum* strikes one as quite uniform in what may be considered a consistent distribution from southeastern Canada south at any rate to North Carolina, west to Minnesota, Iowa and Kansas. It is only along the periphery of such distribution and beyond it that noteworthy variant forms are met with, which introduce real taxonomic problems. The most prominent of these variants is, of course, the third taxon, variety or species *Sommerfeltii*, which remains to be discussed later. It is in Europe the dominant form except in the extreme North, where it is displaced by a form regarded as normal *hispidulum*. In America the *Sommerfeltii* form, as is often the case with European ones, seems to belong to the North and West.

Our southern states show still other variations, the most peculiar one noted already by Grout as new variety *cordatum* (1931). This was based upon a single specimen collected by P. O. Schallert at Moore's Spring near Winston-Salem, North Carolina. I have not seen this particular specimen, but I have clearly the same thing,

sent me by Schallert, collected by Stuart Chapman at Flat Rock near Winston-Salem in 1922. Grout had studied the form carefully and described it in such detail that not much is to be added. The leaves are closely set, widely clasping at base, their broad part as broad as or, in some instances, even broader than long, the acumination quite short, generally much shorter than the broad part, the cells very short, in a large part of the base and sides not over twice as long as broad and not greatly longer in the middle portion, thick-walled, the leaves serrulate throughout their length and with some dorsal roughness from projecting cell ends, some leaves showing a single costa even of considerable length, but this point variable even in leaves of the same stem. The paraphyllia of which Grout speaks are the pseudoparaphyllia, which according to Brotherus characterize the three taxa with which we are concerned but are lacking in the *chrysophyllum* group. As Grout says, the differences might tempt one to think of a distinct species and he has even preempted a specific name for such contingency. Certainly if it had been discovered in an "exotic" locality it would have been hailed as a "nova species." But another specimen also collected by Chapman the next day at Fishel Farm, Winston-Salem and sent by Schallert comes closer to the normal *C. hispidulum*, and I think the new species concept is unnecessary. A specimen collected by S. M. Tracy at Starkville, Mississippi in 1897 and labeled in R. S. Williams' handwriting *Campylium hispidulum* is rather large in all its parts, has leaves more than usually papillose and correspondingly very serrate throughout their length, but otherwise shows general agreement with the species.

For Europe (and Asia) the typical *C. hispidulum* is supposedly confined to the high north—northern Scandinavia and Finland to Siberia (reported from northern Japan)—and specimens available from these regions seemingly differ in no important respect from those of our eastern states. A complication has been introduced by Hagen in the setting up of an independent species from northern Norway, *Hypnum stragulum* (1904, p. 315). Hagen gives a long and detailed description of this species in exemplary Latin and even assigns to it one of Holzinger's Minnesota collections. But Hagen's Scandinavian colleagues have reduced it to a mere variety, not very well marked at that (Brotherus, 1923; Jensen, 1939). It is apparently ignored by Grout. My knowledge of it, apart from the author's detailed description, rests upon a considerable number of Swedish and Finnish specimens of the various forms of *C. hispidulum* kindly furnished me by the ever helpful Dr. Herman Persson, variously labelled by different bryologists as species and varieties, several of them referred to *stragulum*. With all respect

for Hagen's bryological knowledge I am unable to see either from description or specimens any reason to regard this species as falling outside of the normal minor variations of *C. hispidulum* and would drop it altogether, as Grout seems to have done. Differences claimed for the capsule, for instance, appendiculate or nodular cilia, appear to have no consistent value. The appendiculations are slight at best, easily broken off, and the same capsule may show both appendiculate and non-appendiculate cilia. Capsules vary considerably in size and shape, particularly in length.

3. Campylium Sommerfeltii (Myr.) Bryhn. This, whether considered as variety or species, is regularly distinguished from normal *C. hispidulum* by more slender elongated growth, leaves more erect-spreading than squarrose, with narrow base, more gradually narrowed to a long acumination, leaf cells longer and narrower and, it may be added, with less tendency to papillosity, which corresponds with the lessened serrulation. In Europe, as already stated, this separation has been recognized for a long time, and my own more limited experience tends to confirm it. I have collected *Sommerfeltii* in southern Norway and among the Swedish specimens sent me by Persson *Sommerfeltii* is the form of the southern part, including the islands Öland and Gotland, *hispidulum* of the northern. In the middle portion there seems to be some overlapping of range, *hispidulum* occurring as far south as Uppland, *Sommerfeltii* as far north as Jämtland. Some of the specimens from middle Sweden are also more difficult to place, more intermediate in character. The two that I have from Finland are *hispidulum*. Hagen excludes *Sommerfeltii* from northern Norway. Europe south of the Scandinavian peninsula and Finland, including the British Islands, has generally been credited only with *Sommerfeltii*, and this applies to the specimens which I have seen. I note, however, a very recent report of *hispidulum* from Great Britain (Jones & Warburg, 1956). In America, though Grout indicates no especial geographical separation, it is my impression that the *Sommerfeltii* form represents the variant in the north and west. A specimen collected by Lepage on an island in the Albany River in northern Ontario, which I determined as *C. hispidulum* might better be referred to the *Sommerfeltii* form or is at any rate near it. I also have this form from Alaska and it extends southward into Mexico, from which I have two specimens, one so named by Thériot. Bartram (1949) lists several localities for it in Guatemala.

The question which I have hitherto left in abeyance as to whether *Sommerfeltii* is a species or a variety of *hispidulum* I can only answer in the latter sense. In *hispidulum* the leaves toward

the ends of the branches or on weaker branches tend to be of the *Sommerfeltii* type; in *Sommerfeltii* it is not difficult to find squarrose or nearly squarrose leaves, and, in fact, those of the tropical American forms tend strongly in this direction. *Sommerfeltii* gives rather the impression of a less robust and less well developed form, and to draw a definite line between the two on any character or combination of characters is so difficult that one doubts that different bryologists would always draw it in the same place. In fact, such doubt is confirmed in the case of the above mentioned Swedish specimens. I see then no good reason to disagree with the present prevalent opinion that the form under consideration should be called *C. hispidulum* var. *Sommerfeltii* (Myr.) Lindb. but should be retained as a taxonomic unit, especially on account of its tendency to a different geographical distribution.

As Brotherus in both editions of Engler and Prantl has included in this section of *Campylium*, under new combinations, several species suggesting still wider distribution. I have asked to see those represented in the Mitten Herbarium and am grateful to the New York Botanical Garden authorities for the kind compliance with my request. My conclusions on the three specimens sent me are as follows:

a. The *Campylium hispidulum* specimen which furnished the occasion for Mitten to create the genus was collected by Weir (Lindig and Weir in description) in the "Andes Bogotenses" (*i.e.*, Colombia). It is like the other tropical American specimens from Mexico and Guatemala which are called var. *Sommerfeltii*, but rather more compact with leaves broader and shorter acuminate; that is, it is somewhat nearer the normal *hispidulum*.

b. *Campylium praegracile* (Mitt.) Broth. This, placed by Mitten in *Ctenidium*, was collected by Spruce in a cave in the "Andes Quitenses" (*i.e.*, Ecuador). It is a slender form as the name suggests, but quite similar to the specimens from Mexico referred to var. *Sommerfeltii*, to which it may then be reduced. It extends the range of the species a step farther in South America. Brotherus also has a *C. trichocladum* (Tayl.) Broth. from Ecuador, but this I have not seen. Mitten lists it as *Ctenidium* (published originally as *Pterogonium*), but separate from his *C. praegracile* on the same page. Brotherus also has a *Campylium squarroso-byssoides* C.M. from Argentina. I have seen no specimen of this, but the unpublished drawing of it by Georg Roth leaves practically no doubt that it belongs in the same category as the other South American collections.

c. *Campylium lacerulum* (Mitt.) Broth. from "India Orientalis," collected by Wallich, was placed by Mitten in *Stereodon*

but compared with *S. Sommerfeltii*. This is a different case; it looks superficially a little like a weakened *C. Halleri* and has some of its leaves recurved as in that species but is hardly referable to it. Very conspicuous are its large perichaetia with perichaetial leaves also differing from those of the other species. These had evidently impressed Mitten as he had made a pencil sketch of them and they doubtless constitute the reason for his specific name. The *C. lacerulum* (Mitt.) Broth. should apparently stand as a good and well named species.

In summary, the above is meant to confirm the opinion of Mitten and Lindberg in contrast to that currently prevalent, that *Campylium* belongs in the present restricted family Hypnaceae rather than in Amblystegiaceae, that *Chrysohypnum* (also *Campylophyllum*) are synonyms of it and should be dropped, and that it includes only *C. Halleri*, the variable and widely spread *C. hispidulum* with its noteworthy variety *Sommerfeltii* and an additional species *C. lacerulum* from the Himalayan region. *C. chrysophyllum*, *C. stellatum* and others associated with them are excluded and left in the Amblystegiaceae.

Literature Cited

Andrews, A. L. 1954. Taxonomic notes. XII. The families Rhytidiaceae and Hylocomiaceae. The Bryologist 57: 251-261.

Bartram, E. B. 1949. Mosses of Guatemala. Fieldiana: Bot. 25: i-v, 1-442. *Fig.* 1-190.

Brotherus, V. F. 1923. Die Laubmoose Fennoskandias. xiii + 635 pp. *Fig.* 1-118. Helsingfors.

———. 1925. Musci. *In* Engler & Prantl, Die natürlichen Pflanzenfamilien. Ed. 2. Vol. 11. Leipzig.

Bruch, P., W. P. Schimper & T. Gümbel. 1853. Bryologia Europaca. Fasc. 55-56. *Amblystegium*, pp. 1-17, *pl.* 1, 2, 2', 3-11; Suppl. pp. 1-2, *pl.* 1. Stuttgart.

Grout, A. J. 1931. Subfamily Amblystegieae. *In* Moss Flora of North America north of Mexico. Vol. 3, pp. 63-114. Newfane, Vt.

———. 1932. Subfamily Hypneae. *Op. cit.*, pp. 121-154.

Hagen, I. 1904. Musci norvegiae borealis . . . Trømso Mus. Aarsheft 21-22 (1898-99): i-xxiv, 1-382. *Pl.* 1-2.

Haller, A. von. 1768. Historia Stirpium Indigenarum Helvetiae inchoata . . . 3 vol. (in 1). Bern.

Jensen, C. 1939. Skandinaviens Bladmossflora. 535 pp. København.

Jones, E. W. & E. F. Warburg. 1956. *Campylium hispidulum* (Brid.) Mitt. in Britain. Trans. Brit. Bryol. Soc. 3(1): 66-68. *Fig.* 1.

Kindberg, N. C. 1890. Contributions to Canadian bryology.—No. 3. Bull. Torrey Bot. Club 17: 271-280.

Lindberg, S. O. 1879. Musci Scandinavici in systemate novo naturali dispositi. 50 pp. Uppsala.

Loeske, L. 1908. Die Moose des Arlberggebietes. Hedwigia 47: 156-199. (1907.)

———. 1910. Studien zur vergleichenden Morphologie und phylogenetischen Systematik der Laubmoose. 224 pp. Berlin.

Mitten, W. 1869. Musci austro-americani. . . . Jour. Linn. Soc. London, Bot. 12: 1-659.

MÖNKEMEYER, W. 1927. Die Laubmoose Europas. *In* Rabenhorst, Kryptogamen-Flora von Deutschland, Österreich und der Schweiz. IV. Band, Ergänzungsband. Leipzig.

ROTH, G. 1899. Uebersicht über die Familie der Hypnaceen. Hedwigia 38(Beibl.): (3)-(8).

SCHIMPER, W. P. 1876. Synopsis Muscorum Europaeorum . . . Ed. 2. 2 vols. Stuttgart.

SULLIVANT, W. S. 1856. The Musci and Hepaticae of the United States east of the Mississippi River. Contributed to the second edition of Gray's Manual of Botany. iv + 113 pp. New York.

SWARTZ, O. 1781. Methodus Muscorum illustrata quam . . . praeside . . . Carolo a Linné . . . proponit Olof Swartz. 38 pp. 2 *pl.* Uppsala.

THE SPOROPHYTE OF MNIUM HYMENOPHYLLUM

KJELD HOLMEN[1]

Mnium hymenophyllum has a rather wide arctic distribution, but in Greenland has been found only on the west coast, in the provinces from 66° to 72° N. lat. It is especially common in the northern part of this area, where basalts are prominent in the mountains. The male plant is common everywhere, while the female one is very rare. It was accordingly to be expected that the (as far as I know) unknown sporophyte of the species could be found in West Greenland. And it was really found there.

During a stay at the Arctic Station in Godhavn on Disko Island in the summer of 1956 I happened to collect it in two places during an excursion to Disko Fjord. The first collection was made at Igdlokasik on June 19. Twelve well-developed fruiting specimens were found in a bog there; they were all from the preceding summer. Two days later I found a large tuft with numerous old capsules at Nipisat. Later in the summer, on July 13, I collected two specimens with green capsules in a bog at Umiarfik Fjord on Svartenhuk Peninsula.

DESCRIPTION OF THE SPOROPHYTE

Capsules single. Seta erect, 3-4 cm. long, light brown. Capsule brown, arcuate, 4-5 mm. long. Operculum (seen only on unripe capsules) hemispherical with a short point. Exothecial cells thick-walled, especially near the mouth of the capsule. Stomata restricted to the neck, clearly superficial. Peristome of the common diplolepidous type. Exostome-teeth yellow, ventral side with 25-40 lamellae, of which the lower ones often are connected

[1] Universitets botaniske Museum, Gøthersgade 130, København K, Danmark.

with cross-walls. Endostome almost as high as the exostome. Basal membrane high, segments fenestrate and finally gaping, slightly papillose at the tip. Cilia rather short or rudimentary, not appendiculate. Spores 15-25 μ, yellowish-green, finely roughened. Ripening in summer.

Discussion

Mnium hymenophyllum Bruch, Schimper & Gümbel is based upon material collected in Dovre, Norway, by Schimper. The description appeared in the *Bryologia Europaea* (1846). Only the gametophyte and the male "flowers" were described and figured. It was referred there to the genus *Mnium*, which is quite understandable, although the sporophytes were unknown. This name was unaltered until Lindberg (1868) changed it to *Cinclidium* (?) *hymenophyllum* (BSG) Lindb. Lindberg considered it a *Cinclidium* because of its similarity in general appearence to *C. arcticum* and its rather small perigonial leaves, and also because of similarity in ecology. Many authors of larger manuals followed Lindberg, *e.g.* Limpricht (1895), Brotherus (1923, 1924), and Möller (1926). In recent literature the species has again usually been placed in the genus *Mnium*.

Concerning the taxonomic validity of *Mnium hymenophyllum*, the rank of species was called in question by Dixon (1909). He placed it in the older *Mnium hymenophylloides* Hüb. Dixon considered (p. 34)" that *M. hymenophylloides* is a variety at most, in fact not more than a rupestral form of *M. hymenophyllum*." Very few bryologists agreed with Dixon, and Persson (1914) pointed out that even as to the gametophytic characters the two species are well separated although they seem related.

As the sporophyte of *Mnium hymenophyllum* was unknown, it was therefore difficult to give the species its right systematic position. It was expected that the discovery of the sporophyte would solve all these problems. The recent finding of it in West Greenland shows that there are still some questions of the systematic position which may keep the discussion open.

It may, however, be stated at once: *Mnium hymenophyllum* is not a *Cinclidium*, as the peristome is quite normal. The question remains: is it a *Mnium*? Also here the answer is in the negative, in spite of the fact that most of the gametophytic characters indicate this. Three important things separate it from this genus. These are (1) the strongly arcuate capsule, (2) the superficial stomata and (3) the reduced cilia of the inner peristome. The three characters mentioned, however, call attention to the family Meesiaceae. This small family is rather heterogeneous, consisting

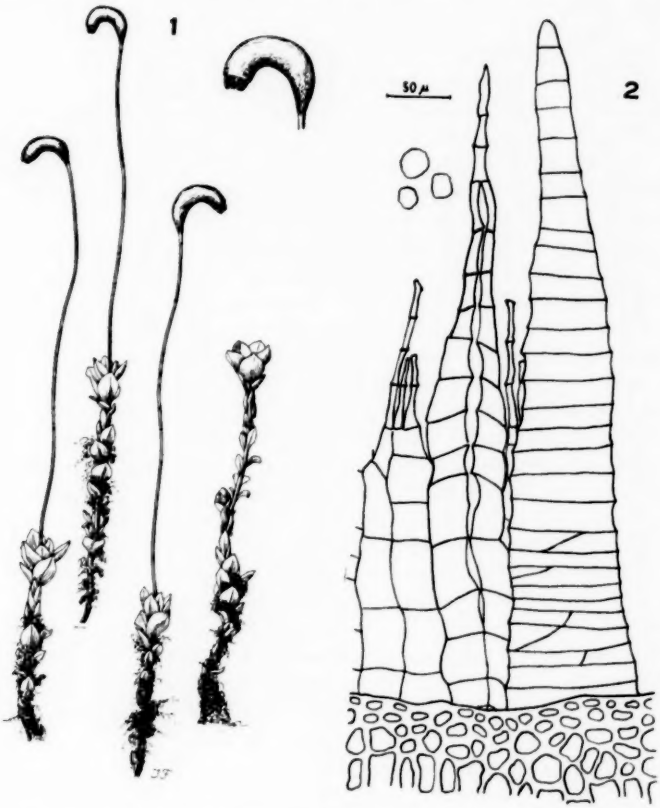

FIG. 1-2. *Cyrtomnium hymenophyllum*. 1. Three female plants with sporophytes and one male plant, × 2; a capsule, × 4. *Drawn by Ingeborg Frederiksen.* 2. Peristome and spores; endostome as seen from the dorsal side; exostome tooth also from the dorsal side but only the ventral contours shown.

of three very different genera, *Paludella, Mecsia* and *Amblyodon*. As regards the sporophyte, *Mnium hymenophyllum* comes closer to *Paludella* than to any species within the Mniaceae. The species is nevertheless retained here in the *Mniaceae,* because the gametophyte is clearly closest to *Mnium*. Thus the stems in cross-section are pentagonal. The sections further show a large well-separated central strand and a very distinct layer of cortical cells. The leaves are of a type commonly met with in the Mniaceae; they are large and broad and have a distinct border and a strong costa. In the

costa guide-cells are present besides a clear group of "leptoid" cells (*Begleiter*).

The special characters of the sporophyte, however, do not make it possible to place the species in any known genus within the Mniaceae. Accordingly, it seems necessary to place it in a new genus, and I propose here:

Cyrtomnium n. gen. Mnio affine, theca arcuata-incurva (unde nomen) stomatibus superficialis ciliis dimidio circiter brevioribus appendiculis destitutis ab eo diversum.

Species typica: **Cyrtomnium hymenophyllum** (Bruch, Schimper et Gümbel) n. comb. *Mnium hymenophyllum* Bruch, Schimper & Gümbel, Bryol. Eur., fasc. 31, *Mnium* Suppl. 1: 5. *Pl.* 5. 1846.

As a result of the foregoing, the old discussion of the relationship between *Mnium hymenophylloides* and *M. hymenophyllum* has again become topical. In other words, is *Mnium hymenophylloides* also referable to *Cyrtomnium* or not? The only sporophyte of this species ever found was collected by Herman Persson. According to Persson's description and figures (1914), the sporophyte seems rather old and poor. The form of the capsule seems to be like that of *Mnium*, but as the stomata were undescribed, we must wait for new finds of fruiting specimens, before this discussion can be finished. In common with *Cyrtomnium* are, however, the rather small spores and the reduced cilia of the inner peristome.

Grateful acknowledgment is due to the Universitetets Arktistke Station i Godhavn and to Grønlands Geologiske Undersøgelse for grand hospitality in the summer of 1956, furthermore to the Carlsberg Foundation for financial grants and to Tyge Christensen, M.Sc., for latinizing the diagnosis.

Literature Cited

Brotherus, V. F. 1923. Die Laubmoose Fennoskandias. Helsingfors.

———. 1924. Musci (Laubmoose). 1. Hälfte. *In* Engler & Prantl, Die natürlichen Pflanzenfamilien. 10. Band. Leipzig.

Bruch, P., W. P. Schimper & T. Gümbel. 1846. Bryologia Europaea. Fasc. 31, *Mnium* Suppl. 1: 1-6. *Pl.* 1-5. Stuttgart.

Dixon, H. N. 1909. A contribution to the bryology of Tornean Lapmark; with a discussion on the relationship of *Mnium hymenophyllum* and *M. hymenophylloides*. Rev. Bryol. 36: 27-36, 59-66.

Lindberg, S. O. 1868. Observationes de Mniaceis europaeis. Not. Sällsk. pro Fauna et Flora Fenn. Förh. 9: 39-88.

Limpricht, K. G. 1895. Die Laubmoose Deutschlands, Oesterreichs und der Schweiz. *In* Rabenhorst, Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz, Ed. 2, Vol. 4. Leipzig.

Möller, H. 1926. Lövmossornas utbredning i Sverige. X. Mniaceae. Ark. f. Bot. 21A: 1-196. *Fig.* 1-50.

Persson, H. 1914. Bladmossfloraen i sydvästra Jämtland och angränsande delor af Härjedalen. Ark. f. Bot. 14(3): 1-70.

MOSSES FROM THE UNITED STATES ANTARCTIC SERVICE EXPEDITION, 1940-41.

EDWIN B. BARTRAM[1]

The collections listed in detail below probably give an adequate idea of the limited moss flora of this desolate, forbidding region restricted in land exposures and subject to brutal climatic conditions.

Fifteen of the 25 recorded species are either identical with or closely related to those of the arctic regions of the Northern Hemisphere. The preponderance of bipolar elements is a striking feature closely related to the origins and distribution of global plant life which offer such a challenging problem for the future.

Most of the localities are represented by a single field number under which all of the local gatherings were combined in a single container. The process of separating this mixture into its component parts has been done as carefully as possible, but many of the resulting aggregates are probably of a composite nature. Where there were obvious differences in color or habit the segregates were given separate numbers consisting of the original field number followed by a period and an arbitrary figure, but where they were similar in appearance and evidently from nearly identical exposures the tufts or cushions were combined to avoid endless duplication.

According to information supplied by Mr. E. P. Killip of the United States National Museum the collecters were as follows: Nos. 1-100, *H. M. Bryant;* 101-210, *J. E. Perkins;* 211-236, *H. P. Gilmour;* 237-303, *R. S. Fitzsimmons;* 304-325, *R. G. Frazier* & *F. A. Wade;* 326-399, *P. A. Siple.*

A representative series from the collection is in my herbarium, and a complete set will be deposited in the herbarium of the United States National Museum, Washington, D. C.

ANDREAEACEAE

ANDREAEA RUPESTRIS Hedw. Melchior Archipelago; Lysted Island, N.E. Landing, 244.4 Lambda Island N.E. Landing, 345.3. Lambda Island, Sevilla Landing, 347.7, 348.4. Lysted Island, 360. Lysted Island, alt. 20-30 ft., 371.6. Lysted Island, north face, 372.6, 372.11, 374.1. Lysted Island, Water Landing, 375, 376.3, 376.

DITRICHACEAE

CERATODON PURPUREUS (Hedw.) Brid. Melchior Archipelago: Lysted Island, 335.11. Lysted Island, north face, 374.3.

[1] Bushkill, Pike Co., Pennsylvania.

CERATODON GROSSIRETIS Card. Near Cape Eilson, Wedell Coast, 70°30′ S., 61°34′ W., No. 59.

DICRANACEAE

DICRANOWEISIA GRIMMIACEA (C. M.) Broth. Melchior Archipelago: Lysted Island, NE. Landing, 344, 344.1. Lambda Island, NE. Landing, 345. Lysted Island, 360.6. Lysted Island, Water Landing, 375.1. Lysted Island, Channel Point, 378.9.

POTTIACEAE

BARBULA BYRDII Bartr. Mt. Marujupu, in deep crevices in granite, 129a.

POTTIA HEIMII (Hedw.) Fürn. Neny Island, 68°12′ S., 67°05′ W., 45 ft. above water, 36.

SARCONEURUM GLACIALE (H. f. & W.) Card., 84, no data. Rockefeller Mts.: Mt. Patterson, SW. slope, SE. ridge, at Snow Petrel Rookery, 276.

Tortula conferta Bartr. sp. nov. Caespitosa, caespitibus densis, viridibus, intus fuscescentibus. Caulis gracilis, 5-7 mm. altus, ramosus, haud radiculosus. Folia aequaliter conferta, sicca erecta, leniter contorta, humida patens, oblongo-ovata, 1-1.5 mm. longa, obtusa, pilo hyalino, denticulato terminata; marginibus planis, superne papilloso-crenulatis; costa tenuis, infra apicem folii evanida; cellulae superiores subquadratae, haud incrassatae, obscurae, dense papillosae, basilares rectangulares, hyalinae, laevissimae, parietibus tenuibus. Fructus ignotus.

Melchior Archipelago: Lysted Island, 335.12, type, mixed with *Brachythecium antarcticum*. Lambda Island, NE. Landing, 345.1, mixed with *Pohlia cruda* var. *imbricata*.

The slender habit, small size and hair-pointed leaves with the upper lamina cells densely papillose with multifid papillae appear to be good diagnostic characters in comparison with other austral American species.

GRIMMIACEAE

GRIMMIA ANTARCTICI Card. Mt. Marujupu: crevices in main granite rock mass, in granitic sand, B24. Peak No. 167, cracks in dike, B48. Peak No. 244, south side of gray granite peak near snowline, 224, mixed with *Sarconeurum glaciale*. Peak No. 231, low exposure near snowline, 227. Mt. Patterson: southwest slope, southeast ridge, at Snow Petrel Rookery, 274, 277b, 282. Rockefeller Mountains: Mt. Tenant, 304. Northern Group of Rockefeller Mts., 323. Var. PILIFERA Bartr. Peak No. 167, on granite sand in cracks of dike, B50. Var. PERCOMPACTA Bartr. Rockefeller Mts.: Mt. Helen Washington, side of main peak, 258.

GRIMMIA APOCARPA Hedw. Melchior Archipelago: Lambda Island, Sevilla Landing, 348.8.

GRIMMIA PLAGIOPODA Hedw. Mt. Marujupu: in crevices on granite near rookery, B37. Archipelago Shetland del Sur: Isla Decepción, *Ruíz Leal* No. 13230.

As far as I know, no species of the Section Gasterogrimmia has ever been reported from the Antarctic regions. If there are any distinctions between the above collections and typical *G. plagiopoda* from North America I fail to find them. The plants are autoicous, the peristomate capsules unsymmetrical and ventricose at the base on a short curved seta, the calyptra mitriform and the leaves unistratose above.

G. plagiopoda is known only from central Europe and temperate North America so these collections represent an astonishingly wide extension of its geographic range. Dr. Leal's collection from the Archipelago Shetland del Sur is apparently exactly the same thing and indicates that the species may eventually turn up from other localities in the Antarctic area.

Grimmia plagiopoda var. **antarctica** Bartr. var. nov. Caespitibus densis, foliis brevioribus, obtusis, minutissime apiculatis. Fructus ignotus.

Mt. Marujupu: in crevices on granite near rookery, B37.1.

This appears to be a form of *G. plagiopoda* with the leaves all obtuse and very shortly hyaline-apiculate similar to the lower leaves of typical plants. It is very distinct in appearance from the typical form listed above and evidently is from a different exposure. The leaves are uniformly similar in structure and appearance to the smaller lower leaves of the typical plants.

GRIMMIA ALPICOLA var. RIVULARIS (Brid.) Broth. Melchior Archipelago: Lysted Island, 360.3.

GRIMMIA DONIANA Sm. East Base: top of nunatak, 150 ft. above glacial ice, 68°00′ S., 67°47′ W., growing deep in crack, 65. Melchior Archipelago: Lysted Island, Water Landing, 376.2.

BRYACEAE

POHLIA CRUDA (Hedw.) Lindb. Melchior Archipelago: Lambda Island, Sevilla Landing, 348.1. This is the only collection showing the leaves loosely erect-spreading as in the typical form. All of the others are referred to the var. *imbricata*.

Pohlia cruda var. **imbricata** (Card.) Bartr. comb. nov. *Webera cruda* var. *imbricata* Card., Rev. Bryol. 27: 43. 1900. Melchior Archipelago: Lysted Island, 335, 360.5, 361.2. Lysted Island, Chain Point, 377.2. Lysted Island, Water Landing, 377.6. Lysted Island, north face, 372.5. Lysted Island, south face, alt.

20-30 ft., 371.4. Lambda Island, NE. Landing, 345.2. Lambda Island, Sevilla Landing, 347, 348. East Base, 92, 92b, no data.

POHLIA NUTANS (Hedw.) Lindb. Melchior Archipelago: Lysted Island, 335.13, 360.8. Lysted Island, alt. 20-30 ft., 371.7. Lysted Island, Chain Point, 377.3. East Base: 201, no data.

BRYUM INCLINATUM var. MAGELLANICUM Card. Melchior Archipelago: Lysted Island, 361.1. Lysted Island, NE. Landing, 344.6. Lysted Island, south face, alt. 20-30 ft., 371.1. Lambda Island, Sevilla Landing, 347.3. Anchorage Island, 361.4. East Base: Lagotelleria Island, 67°54′ S., 67°25′ W., 48a.1.

BRYUM SIPELEI Bartr. Rockefeller Mountains: Mt. Patterson, SW. slope, SE. ridge, at Snow Petrel Rookery, 276.1.

BRYUM ANTARCTICUM H. f. & W.—East Base, 91, no data. Neny Island: 68°12′ S., 67°06′ W., west slope, 40 ft. above water, 29. Lagotellerie Island: 67°54′ S., 67°25′ W., 48.2a. Melchior Archipelago: Lysted Island, 335.3, 360.4, 361. Lysted Island, NE. Landing, 344.5. Lysted Island, alt. 20-30 ft., 371.8. Lysted Island, south face, alt. 20-30 ft., 371.2. Lysted Island, north face, 372.2. Lambda Island, Sevilla Landing, 347.6, 348.7. Anchorage Island, 361.5. Generally distributed but uniformly sterile.

BARTRAMIACEAE

BARTRAMIA PATENS Brid. Neny Island: 68°12′ S., 67°7′ W., 300 ft. above water, 23, 24. Melchior Archipelago: 360.1, 360.2. Lysted Island, Channel Point, 378.3, 378.7. Lysted Island, Chain Point, 377.1. Lysted Island, 335.4. Lysted Island, alt. 20-30 ft., 371.11. Lysted Island, Water Landing, 376.4. Lysted Island, south face, alt. 20-30 ft., 371. Lysted Island, NE. Landing, 344.7, 345.8. Lysted Island, north face, 372.10, 374.2. Lambda Island, Sevilla Landing, 347.1, 347.5. Frequent and often richly fruited.

AMBLYSTEGIACEAE

DREPANOCLADUS UNCINATUS (Hedw.) Warnst. Melchior Archipelago: Small Island NE. of Lysted Island, 356. Gordon Lien Island, 353, 353.1. Bailey Island, 350. Lysted Island, 360.9, 360.7, 335.5. Lambda Island, Sevilla Landing, 347.2, 348.5. Lambda Island, NE. Landing, 345.9. Lysted Island, NE. Landing, 344.3. Lysted Island, north face, 372.9, 374. Lysted Island, Water Landing, 375.2, 376.1, 373, 375.3′(caudate form), Lysted Island, south face, alt. 20-30 ft., 371.3. Lysted Island, alt. 20-30 ft., 371.9. Lysted Island, Chain Point, 377.4. Lysted Island, Channel Point, 378.2 and 378.6 (caudate form).

To judge from the number and quantity of the above collections this is by far the most frequent and abundant moss in the Melchior

Archipelago area. Some of the collections show many or most of the plants prolonged at the tips into slender, microphyllous, whip-like tails. This feature is also found in collections of *Brachythecium antarcticum* and may be the result of unnatural growing conditions under snow.

BRACHYTHECIACEAE

BRACHYTHECIUM ANTARCTICUM Card. Lagotellerie Island: 67°54′ S., 67°25′ W., 48a.3, with *Bryum antarcticum*. Lysted Island, 335.2, 361.3. Lysted Island, Channel Point, 378 (caudate form), 378.1. Lysted Island, south face, alt. 20-30 ft., 371.5. Lysted Island, NE. Landing, 344.2. Lambda Island, Sevilla Landing, 347.4. Lambda Island, NE. Landing, 345.4. Small Island, NE of Lysted Island, 357.

HYPNACEAE

HYPNUM REVOLUTUM (Mitt.) Lindb. George VI Sound, 87d.

POLYTRICHACEAE

POGONATUM ALPINUM (Hedw.) Roehl. Lysted Island, alt. 20-30 ft., 371.10. Lysted Island, north face, 372. Lysted Island, Chain Point, 377.5. Lysted Island, Channel Point, 378.4 Lambda Island, NE. Landing, 345.10. Lambda Island, Sevilla Landing, 348.3. Var. BREVIFOLIUM (R. Br.) Brid. Lysted Island, 335.15. Lysted Island, north face, 372.1.

POLYTRICHUM SUBPILIFERUM Card. Lysted Island, 335.14.

TORTULA PAPILLOSA IN NEW MEXICO[1]

WILLIAM A. WEBER[2]

The distribution of *Tortula papillosa* Wils. was reviewed in some detail by Schnooberger (1942) following her discovery of the species for the first time in Michigan. This species has a noteworthy distribution pattern involving major disjunctions between North and South America, Europe, Africa and Australasia. That *T. papillosa* almost exclusively reproduces by vegetative propagula probably has a bearing on the fact that it can exist today in a number of widely separated areas but at the same time maintain a remarkable morphological and presumably genetic homogeneity.

[1] Research supported by the Univ. of Colorado Council on Research and Creative Work.

[2] Dept. of Biology, University of Colorado, Boulder, Colo.

If the single, simple papillae of the laminal cells of the phylloids, a unique feature in this species, constitute a primitive characteristic, then the peculiar disjunct distribution would appear to indicate a relic survival of very long standing. Since such species are critical to an understanding of historical biogeography, it is of importance that information on their present distribution be brought up to date whenever significant new data accumulate.

The principal range of *Tortula papillosa* in North America is in the eastern United States and Canada from Nova Scotia southward to Tennessee and South Carolina and westward to Ohio and Michigan. Schnooberger cited single collections, each lacking supporting data, from Illinois and from California. Thus, in the United States, there was a major hiatus in the distribution pattern involving almost all territory west of the Mississippi River. From the scanty evidence of its occurrence in California, Schnooberger predicted a much wider distribution throughout the western and central United States.

Koch (1950) put the California report on a firmer basis by citing two recent collections: on trunk of *Quercus agrifolia*, Hastings Reservation, Monterey Co., *Linsdale* 134a; Angels Camp, Calaveras Co., *R. R. Koch*.

What appears to be the first intermediate station for *Tortula papillosa* between California and Illinois was reported by Haring (1954) for Arizona: Apache Indian Reservation, Apache Co., 9,500 ft., *W. S. Phillips*, 1949 (H-9060).

To fill further the existing gap in our knowledge of the distribution and to bear out Schnooberger's prediction, I am pleased to be able to report a station in New Mexico for *Tortula papillosa*. A good series of the characteristically sterile plants was collected in 1956 on an excursion to the Sandia Mountains east of Albuquerque. These were found exclusively on the bark of large trees of *Quercus gambelii* Nutt. at the approximate upper altitudinal limit of oak along the Sandia Loop Highway below Sandia Crest, and were encountered at only one collecting site: BERNALILLO CO.: head of Madera Canyon, east side of Sandia Mountains, 8,700 ft. alt., T. 11 N., R. 5 E., 26 March 1956, *S. Shushan & W. A. Weber* 108536. Specimens have been distributed to the following herbaria (abbreviations *fide* Index Herbariorum): COLO, DS, CAN, DUKE, WTU, UT, FH.

Since Schnooberger raised the question of the occurrence of papillae on the ventral surface of the phylloids, it may be of interest to note that sections of the New Mexico material show the papillae to be restricted to the dorsal surface except for an occasional ventral papilla on one or two cells nearest the costa.

Although it is too soon to give a definitive statement regarding the substrate common to the species in the Southwest, it may be significant that both the Californian and New Mexican collections were taken on *Quercus*. Schnooberger did not mention this substrate for either the North American nor the European collections, but stated that in Africa *T. papillosa* occurs on *Quercus*.

LITERATURE CITED

HARING, INEZ M. 1954. A check-list of the mosses of the State of Arizona. II. THE BRYOLOGIST 57: 150-155.

KOCH, L. F. 1950. Mosses of California: an annotated list of species. Leaflets of Western Botany 6: 1-40.

SCHNOOBERGER, IRMA. 1942. Distribution of *Tortula papillosa* Wils. THE BRYOLOGIST 45: 24-27. 1 fig.

NOTES ON NEARCTIC HEPATICAE. XII. MARSUPELLA PAROICA N. SP.

RUDOLF M. SCHUSTER[1]

At various times, during the last six years, I have collected a species of *Marsupella* in the Southern Appalachians which superficially resembles *M. emarginata* (Ehrh.) Dum. in several respects, particularly in the tendency for the leaf-margins to be narrowly revolute and in the rather shallow sinus of the leaves. Indeed, the species has been confused in herbaria, and to some extent in the literature, with *M. emarginata*. However, it differs from *M. emarginata* in a whole series of features, most obviously in its inflorescence, leading one to the assumption that a good new species is at hand. This assumption has also been corroborated by Dr. S. Arnell, to whom a portion of the isotype material was sent. At one time I attempted to place the single collection from the Lake Superior area cited below into *M. sparsifolia*, because of the paroecious inflorescence, spreading leaves and small size of the plants. However, such a disposition cannot be maintained, as will be discussed herein. The plant may be described as follows:

Marsupella paroica sp. n.[2] Plants in erect, usually dense tufts, *green to somewhat brownish-tinged* (never purplish, never black),

[1] Dept. of Botany and University Herbarium, University of Michigan, Ann Arbor, Mich.

[2] Similis *M. emarginata* in foliis cum marginibus revolutis, in hyalodermide minime producto, in colore viride aut rubro-brunneo; dissimilis in foliis aliquot angustioribus, ovatis ad ovatorotundis in forma et in inflorescentibus semper paroicis.

(0.5)1-1.5 cm. high. Shoots with leaves to 0.8-1.2 mm. wide (sterile regions), 1.5-1.6 mm. wide (apices of fertile regions), the stems *ca.* 180-215 μ wide × 180-200 μ high. Stem in cross-section *ca.* 13-16 cells high, the cortical layer of cells thin-walled, hyaline, empty, averaging 1.5-2.5 × the area (in cross-section) of the cells immediately interior to them; cells in 2-3 rows immediately within the empty cortical cells very thick-walled, the walls brownish or yellowish-brown, the small lumina nearly filled with chloroplasts; median region of medullary cells again thin-walled, larger (averaging as large as to slightly larger than the cortical cells), hyaline, non-chlorophyllose. Rhizoids few or none on the erect, leafy shoots, colorless. Leaves on sterile shoots *often somewhat succubously oriented*, and slightly succubously inserted, near the tips of shoots (and towards fertile regions) becoming transversely oriented and inserted, *broadly ovate*, averaging widest at or somewhat below middle, the mature sterile ones from 640-700 μ wide × 670-700 μ long to *ca.* 800-850 μ wide × 825-1000 μ long (measured in length from leaf-base), *averaging slightly longer than wide, distinctly unequally bilobed* 1/6-1/5(1/4) *their length, the sinus open, subrectangular to subacute, rarely acute, the lobes subobtuse* (rarely obtuse), *occasionally acute to subacute;* dorsal (and to a lesser degree postical) margin, from the upper one-third of the leaf down, *narrowly but distinctly reflexed* (except on immature leaves). Cells of leaf-middle little longer than wide, strongly collenchymatous with strongly bulging trigones, averaging 18-22 μ wide × 20-25 μ long; marginal cells in a single row much smaller than the cells within them, *ca.* 11-12 μ (measured along the margin), essentially quadrate to short-rectangular, rather strongly, equally thick-walled (and thus contrasted to the strongly collenchymatous cells within); oil-bodies appearing finely granular, spherical to ovoid to ellipsoid, 2(-3) per cell, 5 × 9-10 μ to 6-7 × 10-12 μ (at leaf base to 5 × 12 to 7 × 15 μ).

Paroecious. Male bracts in 2-4(-5) *pairs below the female inflorescence*, more or less strongly imbricate (more so than vegetative leaves), their base distinctly saccate, containing 2-3 (rarely apparently only 1) antheridium per bract; bracts somewhat larger (and relatively broader, thus suborbicular) than vegetative leaves, otherwise similar to leaves (and with margins equally strongly reflexed). Antheridia long-stalked (stalk *ca.* 140 μ long × 22 μ in diameter), the stalk 2-seriate; body ovoid, *ca.* 140 × 185 μ long. Female inflorescence terminal; female bracts suberect, shallowly bilobed, with the short, tubular perianth hidden between them (exactly as in *M. emarginata*). Capsule subspherical, on a

seta *ca.* 0.5-1.5 cm. long, reddish-brown. Wall bistratose; the epidermal cells irregularly oblong to polygonal, *ca.* 19-24 × 30-36 μ, with 1-2 strong nodular thickenings on each longitudinal wall and 0-1 thickening on each transverse wall (the thickenings nodular in outer tangential focus; in inner tangential focus with occasional to frequent, complete to incomplete tangential extensions which sometimes wholly traverse the cell). Inner cell-layer of narrower, longer, more regular cells, averaging 12-14 μ wide × 55-60 μ long, with generally 4-7 strong *nodular thickenings*, which are not or only occasionally (and weakly) tangentially extended. Spores 10-13 μ in diameter.

Soco Falls, NE. of Cherokee, North Carolina (*Schuster* 24203, TYPE). Paratypic and cotypic material as follows: VIRGINIA: Summit of Mt. Rogers, 5715 ft., Grayson Co. (*Schuster* & *Patterson* 38025, 38005); near summit of White Top Mt., *ca.* 5400 ft., Smyth Co. (*Schuster* & *Patterson* 38092a, 38064, 38086). NORTH CAROLINA: Soco Falls, near Cherokee, Swain Co. (*Schuster* 24203, 24203a, 24210, 24724, 36665, 36676); below High Falls of Whitewater R. Gorge, Jackson Co. (*Schuster* 25009a); Craggy Gardens, damp rock near spring, Craggy Mts., *ca.* 5800 ft., Blue Ridge Parkway, Buncombe Co. (*Schuster* 29644a); Clingmans Dome, on trail to Andrews Bald, *ca.* 6200 ft., Swain Co. (*Schuster* 36657a); Andrews Bald, Smoky Mt. Nat. Park, Swain Co., 5800 ft. (*Schuster* 36601, 36610); Chestnut Bald, Balsam Mts., SE. of Sunburst, 6050 ft., Haywood Co. (*Anderson* 11182). TENNESSEE: Greenbrier Pinnacle, 4000 ft., Sevier Co. (*Sharp* 34580, as *M. emarginata*). GEORGIA: Summit of Brasstown Bald, *ca.* 4725 ft., Towns Co. (*Schuster* 34309, 34309a). MINNESOTA: Birch Rock Hill, Nopeming, St. Louis Co. (*Conklin* 3136, 1270, 1279 and 2124!; listed by Conklin, 1942, as *M. emarginata*, and by Schuster, 1953, as *M. sparsifolia*). The Minnesota reports are phytogeographically puzzling, being similar in their disjunction to those of *Diplophyllum obtusatum*.

DISTRIBUTION: Evidently largely restricted to the Southern Appalachians, in which it has a scattered range from Virginia and North Carolina to Tennessee and northern South Carolina and northern Georgia; a disjunct station in the Lake Superior region. Ranging rather widely altitudinally, from *ca.* 3600 to 6200 ft., but at its southern limit evidently only above 4500 ft. The species ranges from the Spruce-Fir zone into the Mixed Mesophytic and Oak-Hickory (Chestnut) Forest regions. Evidently a derivative of *M. emarginata*, and not infrequently found with this, yet remaining constantly distinct.

ECOLOGY: With an environmental range similar to that of the closely affiliated *M. emarginata*, appearing to have a lesser toleration for submersion and apparently unable to occur in as highly insolated areas as *M. emarginata*. The species is found on noncalcareous, rather dry or damp to moist rocks, particularly in humid sites (as in wet recesses of cliffs; on the vertical rock walls

of deeply shaded mountain streams; near cascades and waterfalls in the mountains), often only a short distance above flowing water, and thus in areas with a constantly high humidity. In such places it is associated commonly with the Appalachian endemic, *Solenostoma obscurum*, with *Diplophyllum apiculatum* and (after accumulation of very thin soil layers) *Microlepidozia sylvatica, Cephalozia bicuspidata, Scapania nemorosa* and *Tritomaria exsecta*. *Marsupella paroica* is also found on boulders along swift mountain streams, in more open sites, associated with *Solenostoma crenuliforme, Jubula pennsylvanica* and *Lejeunea lamacerina* s. lat. On drier ledges and boulders in shaded coniferous forests (as on Andrews Bald), it is found with normal *Marsupella emarginata* but not mixed with it and with *Lejunea lamacerina*. In Georgia, at the southern periphery of the range, it grows on shaded damp rocks, with *Diplophyllum apiculatum* and *Andreaea rupestris*. It is also found on shaded and humid, but not moist rocks, also occasionally with *Herberta* and *Lejeunea lamacerina*. *Lejeunea lamacerina*, or a plant perhaps subspecifically distinct from it, appears to be the dominant *Lejeunea* associated with *M. paroica*. This is the plant which has for long erroneously passed in North America as *Lejeunea patens* Ldbg. *Marsupella paroica* is almost always found in deep shade, under *Rhododendron maximum* and/or *catawbiense*, and/or *Tsuga canadensis* (at lower elevations), or under *Abies fraseri* (at higher elevations). In the disjunct station in Minnesota the plant occurs with *Diplophyllum obtusatum*, with which it is found again at the Craggy Gardens station in North Carolina.

DIFFERENTIATION: The paroecious inflorescence, together with the marked superficial similarity to the smaller forms of *M. emarginata*, is the most striking characteristic of this species. Indeed, *M. paroica* can be confused only with *M. emarginata* and *M. sparsifolia*. It resembles *M. emarginata* in facies, in the dull-green to olive-green color, in the essentially orbicular to quadrate-rotund leaves divided by a relatively shallow sinus (generally descending 1/5-1/4) that is obtuse to subrectangular, with the lobes subacute to occasionally even apiculate. The leaves, which spread stiffly and pectinately at an angle of *ca.* 65-85° are also characteristically reflexed (on well-developed shoots) on their antical margins, exactly as in *M. emarginata*. From *M. emarginata* it differs at once in the constantly paroecious inflorescence.

The size of the plants, and the paroecious inflorescence, would result in confusion with *M. sparsifolia*. However, the more spreading leaves, more quadrate-rotund, divided by a much less acute-angulate sinus and to a generally shallower degree, as well as the

absence of the characteristically brown to brownish-black coloration in *M. paroica,* at once separate the two species. *M. paroica* also has smaller cells, 12-14 μ in the leaf-lobes and at the base of the leaf-lobes; in *M. sparsifolia* they measure 16-17 μ. Finally, the antical leaf-margin never appears reflexed in *sparsifolia*—a character occurring in our species of the genus only in *M. emarginata* and *paroica.* Finally, *M. sparsifolia* is a montane and arctic-alpine species that does not occur at low elevations in temperate areas.

The two species also have a very different appearance, *M. paroica* being stiffer, with the widely spreading leaves more pectinately inserted; in *M. sparsifolia* the plants are more lax, the leaves are erect-spreading, not stiffly spreading. The leaves of *M. sparsifolia,* with their deep acute sinus, and (on sterile shoots) their oblong form (distinctly longer than wide) are very different in shape from those of *M. paroica.*

The question must be raised as to whether *M. paroica* can be maintained as a discrete species from *M. emarginata.* Although the latter has never been reported as producing a monoecious inflorescence, it might be possible to consider *M. paroica* a monoecious phase of it. The restricted distribution of *M. paroica* appears to argue against this, since it occurs in the Southern Appalachians, at the southern edge of distribution of the genus (in the eastern United States), and in the "critical" Lake Superior region. Furthermore, it occurs here with other "endemic" segregate taxa of widely distributed types (*Bazzania nudicaulis, Acrobolbus rhizophyllus, Plagiochila sharpii, P. caduciloba,* etc.).

The paroecious inflorescence of this species is easily recognized, since 3-4 pairs of larger leaves, wider than long, quite concave at the base and usually relatively strongly imbricate, usually occur below the perichaetial bracts. These leaves each bear 1-3 antheridia, each of which is (as in the rest of the genus) characteristically long-stalked. The type collection is notable in that there is usually innovation from one of the perigonal bracts, which is soon again "floriferous." Some plants show 3-4 of these innovations—yet none of the older shoots, bearing perianths at the tip, show any trace of capsules.

Perhaps more important than geographic considerations in their separation is the fact that *M. emarginata* and *M. paroica* have been repeatedly found associated, although not intermingled, but retain their distinctive characters, without any evident trace of intergradation. *M. paroica,* in addition to the obvious differences in inflorescence, appears to differ in a series of characters from *M. emarginata,* among them: (1) the leaves are generally somewhat narrower and often unequally bilobed, averaging 0.84-0.95 as wide

as long; (2) the leaves are bilobed for about the same distance, as compared with the terrestrial forms of *M. emarginata*, but the lobes tend to be strongly unequal in the majority of cases and also sometimes tend to be closer together, with their apices separated by 0.35-0.45 the leaf width, *vs.* 0.45-0.65 in "normal" forms of *M. emarginata;* the leaf-lobes are also quite unequal, usually, and more acute in general; (3) the anatomy of the capsule wall is rather different, the inner cells being provided on each wall with generally 4-7 nodular thickenings that are not or hardly tangentially extended *vs.* 7-11 such thickenings of the longer walls in *M. emarginata;* (4) the epidermal layer of cells of the capsule possess fewer thickenings, 1-2 per longitudinal wall and 0-1 per transverse wall, *vs.* 2-4 per longitudinal wall and 0-2 per transverse wall in *M. emarginata;* (5) a possible difference also lies in the fact that in *M. paroica* the epidermal cells have nodular thickenings that are often more or less extended tangentially on their inner tangential faces, while such tangential extensions are absent or rare in *M. emarginata.*

Study of a series of specimens shows serious intergradation in some of these "tendencies," particularly in the leaf-shape and degree of separation of lobes. In the Minnesota material of *M. paroica* some collections show leaves fully as wide as long, widest near the leaf-middle, with widely separated lobes, exactly as in *M. emarginata.* However, other leaves from material from this locality show a distinctly narrower form and differ considerably from normal leaves of *M. emarginata* in form. As a consequence, primary emphasis in separating these two closely allied taxa must be placed on the form of inflorescences, with the differences in anatomy of the capsule-wall needing substantiation through study of a wider series of fruiting specimens than currently available.

There are also certain habitual differences between *M. paroica* and *M. emarginata* which strengthen my belief in the specific distinctness of the two: the leaves are rather consistently asymmetrically bilobed, with the antical lobe smaller in *M. paroica;* the antical base is not as strongly dilated as the postical, hence, *in situ,* the leaves look somewhat different. Dr. S. Arnell expressed the opinion that "*Marsupella paroica* seems to me to be a very distinct species, very clearly different from *M. emarginata.* The shape of the leaves is very different with the small anterior lobe and the base, that somewhat resembles the base of an *Anastrophyllum.*"

Although occasionally with blunt leaf-lobes, *M. paroica* is usually quite distinct from the nearctic phases of *M. emarginata* in having subacute or even acute leaf-lobes. This is particularly well-marked in xerophytic extremes, from dry boulders in deep shade

(mod. *parvifolia-densifolia-viridis*), as in plants from White Top Mt., Virginia (*Schuster & Patterson* 38086). Such plants may be only 0.8-1.0 mm. wide and average 5-10 mm. long.

LITERATURE CITED

CONKLIN, G. H. 1942. The Hepaticae of Minnesota. THE BRYOLOGIST 45: 1-23.

SCHUSTER, R. M. 1953. Boreal Hepaticae, a Manual of the Liverworts of Minnesota and Adjacent Regions. The Amer. Midl. Nat. 49(2): i-v, 257-684, *fig.* 1-16, *pl.* 1-110.

FRULLANIA HAEMATOCYSTA[1]

LOIS CLARK[2]

FRULLANIA HAEMATOCYSTA Spruce, Trans. & Proc. Bot. Soc. Edinburgh 15: 54. 1884. Plants robust, graceful, greenish-red, darker when dry, caespitose, prostrate; leafy stem about 1.5 mm. wide. Stem to 8 cm. long, irregularly and loosely pinnate to bipinnate; primary branches to 3 cm. long, irregularly again branched, ultimate branchlets not attenuate. Leaves of stem contiguous to imbricate, somewhat wrapped about the stem when dry, unequally bilobed. Dorsal lobe obliquely spreading, asymmetric, strongly decurved, broadly ovate, 781-887 μ long, 355-816 μ wide; apex triangular, acute to apiculate; margin entire; dorsal base crossing stem to 1.5 stem-widths beyond, strongly appendiculate, ventral base also somewhat appendiculate, appendiculae orbicular. Ventral lobe grading from saccate to almost explanate, narrowly oblong-cylindric or subclavate, contiguous and parallel with stem or diverging up to 30° angle, twice as long as wide, 279-344 μ long, 227-319 μ wide; mouth very narrow, elongate; apex rounded, more or less cucullate to galeate; plane portion broadly attached to edge of dorsal lobe, line of union often parallel with stem and then extending below edge of dorsal lobe. Leaf subtending branch slightly larger than stem leaf, more or less obovate, entire; apex rounded and apiculate; both bases cordate; ventral lobe at least sometimes present, oblong-cylindric or explanate. First leaf of branch composed of two small explanate lobes or of a normal dorsal and an explanate ventral one. Stylus minute, subulate, a single row of 4-5 cells; end cell the largest, hyaline. Cells of margin of dorsal lobe squarish, about 17 μ; median 23-27 μ long, 18 μ wide, walls

[1] This work was made possible by a grant from the Biological and Medical Research Fund of the State of Washington.

[2] Dept. of Botany, University of Washington, Seattle, Wash.

FIG. 1-25. FRULLANIA HAEMATOCYSTA. 1-4. Various forms of ventral lobe, × 18. 5. Part of plant, ventral view, × 45. 6. Dorsal leaf lobe show-

thin, trigones small; basal cells 32-43 μ long, 20-25 μ wide; occasional cells at base subrotund and large, 51-43 μ; walls of basal cells thicker than of median, trigones larger; inner cells of base intensely colored a golden red; cells of dorsal auriculae colorless, with very thick walls. Underleaves of stem transversely inserted, suborbicular, contiguous to distant, lower half clasping stem, 3 times as long as stem, 426-568 μ long, 355-368 μ wide, 1/4-1/3 bilobed, base cordate, lobes acute to apiculate; margin recurved, entire; marginal row of cells squarish. First underleaf of branch unlobed, triangular-ligulate. Plants bisexual. Male inflorescence on short branch near female one, globose, of 10 bracts; underleaf of male branch unlobed, acuminate; bracts subequally bilobed; dorsal lobe orbicular, apex rounded, margin entire; ventral lobe with small tooth (stylus) on ventral margin; male bracteoles gradually smaller up the inflorescence, unlobed within the inflorescence and reduced to a few cells in the upper part; rejuvenation occasional as short terminal vegetative shoot. Female inflorescence of short lateral branch with first underleaf unlobed. Female bracts shorter and more delicate than stem leaves, unequally bilobed for half their length; dorsal lobe obovate, 604-781 μ long, 240-350 μ wide, acute to acuminate, entire to sinuate, low at base entire to crenulate. Ventral lobe of female bract shorter than the dorsal, united for half its length with the dorsal, concave to canaliculate, oblong-ovate, 426-663 μ long, 142-190 μ wide, apex apiculate; margins entire except for large tooth (stylus) on ventral margin and 4-5 blunt teeth near base. Female bracteole free, oblong-ovate, 520-417 μ long, 380-351 μ wide, ¼-bilobed; lobes acuminate, revolute, more or less falcate, somewhat connivent; margin entire, strongly revolute near base. Perianth long-emersed, club-shaped, 1.6-1.8 mm. long, 670-710 μ wide about middle, when young terete in lower half and 4-angled in upper, when old 4-angled throughout, abruptly contracted to beak; beak 142 μ long, inner surface not papillate. Sporophyte too old for description; spores brown; elaters unispiral, brown, 187 × 17 μ, tapering slightly at both ends. On bark of trees.

---

ing region of intensive coloration, × 20. 7. Female bracteole, × 34. 8. Female bract, × 34. 9. Perianth, old, × 20. 10. Stylus, × 267. 11. Cross-section of perianth, somewhat diagrammatic, × 38. 12. First underleaf of branch, × 42. 13. Apices of lobes of underleaf, × 103. 14. Stem leaf, ventral view, × 27. 15. Part of plant, × 1. 16. Part of plant, dorsal view, × 10. 17. Underleaf of stem, × 42. 18. Apex of dorsal leaf lobe, × 190. 19-21. Various forms of first leaf of branch, × 60. 22. Male inflorescence, × 27. 23. Apical cells of dorsal lobe, × 267. 24. Median cells, × 267. 25. Basal cells, × 267. (All drawings by Bertha Pitcher from *Lopez* 1143.)

TYPE: Pallatanga Andium Quitensium, alt. 1800 m., ad arbores, *Spruce*. SPECIMEN EXAMINED: PERU, Cerro Campana, Prov. Trujillo, Dept. of La Libertad, alt. 500 m., *A. Lopez* 1143, Aug. 6, 1955. Also a packet in the U. S. National Herbarium, and apparently a part of the type collection.

Frullania haematocysta when sterile resembles *F. conferta* in general appearance and form of ventral leaf lobe but differs in the intense coloration of the median cells in the basal region of the leaf, the acuminate dorsal leaf lobe, the large underleaves and the small, subulate stylus. In fertile material the striking features are the long-emersed perianth and the short delicate involucre.

JAMAICA LICHENS. SOME UNREPORTED COLLECTIONS

W. L. DIX[1]

One of the earliest accounts of lichens in Jamaica is found in Sloane (1707) in which nine different species seem to have been recognized under polynomials, such as, *Muscus tenuis et capillaceus cinerei coloris e ramis dependens.* The next account of Jamaican lichens was that of Patrick Browne (1789). He used the generic names of *Cladonia, Placodium, Platisma* and *Usnea* and listed 19 different kinds but with no specific names, as for example, "Cladonia 2. *Cinerea erecta ramosissimus, ramulis obtusis.* The erect Cladonia with obtuse branches."

Fée (1824) probably published the first account of lichens in Jamaica with specific names. Various species, such as "*Circinaria cocoes,* Habitat in Jamaica etc . . ." are attributed to Jamaica among other species mostly from South America, Mexico and the Caribbean. A fuller and more detailed account of Jamaican lichens was published by Vainio in 1915. He listed 49 lichens collected by Børgessen, Eggers, Hansen and Isert. An early list of lichens collected by an American was published by Riddle (1912). This collection of 114 specimens was made by Clara Eaton Cummings in February and March of 1905. Another list by Heber Howe, Jr. (1914) is an account of some 20 specimens collected in 1903 and 1906 by Duncan S. Johnson. A second list by Riddle (1917) listed 12 species; the collector was Joseph A. Cushman, assistant curator of the Boston Society of Natural History. Plitt (1921) published a running account of some lichens collected by himself and others near Cinchona Botanical Station.

[1] Philadelphia Academy of Natural Sciences, 19th and the Parkway, Philadelphia, Pa.

In the classification of the folowing lichens Zahlbruckner's *Catalogus Lichenum Universalis* has been followed, with some exceptions, especially in the *Cladoniae*. In this latter group I have adopted the classification used by Dr. A. W. Evans, who has identified all the *Cladoniae*. Most of the *Stereocaula* were identified by Dr. I. Mackenzie Lamb. Several folicolous lichens were identified by Rolf Santesson. Most of the rest of the lichens were determined by Dr. Carroll W. Dodge. I am very grateful to them for their kind assistance. The report accounts for 163 taxa and is a complete list of all the unreported Jamaican lichens in the herbarium of the Academy of Natural Sciences in Philadelphia. Most of the material was collected by staff members of the Science Museum of the Institute of Jamaica, mostly within the last decade. The following collectors will be referred to in the report only by surnames: C. Bernard Lewis, George R. Proctor, Amy von der Porten, Marie L. Farr, R. P. Bengry, and William Seifriz. The accession numbers of the Institute of Jamaica are used in most instances; four-digit numbers are Proctor's collection numbers.

ANAPTYCHIA GRANULIFERA (Ach.) Mass. ST. ELIZABETH: Quickstep, behind School-house Hill, alt. ca. 1250 ft., on *Annato* sp., *von der Porten*, 228. ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten*, 200. Var. ANTILLARUM Vain. Same data as for no. 200 above, 210.

ANAPTYCHIA HYPOLEUCA (Müll. Arg.) Mass. Cinchona, 1919, *Seifriz*. ST. ANDREW: On trail from St. Helens Gap to Morces Gap, alt. 4800-4900 ft., *Lewis*, 28. ST. THOMAS: Below Portland Gap, alt. 4200-5500 ft., on rock, *Farr*, 346. Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor* 5180, 5183. Var. SOREDIIFERA Müll. Arg. ST. ANDREW: Near Charlottenburg, alt. 3500 ft., *Proctor* 284. ST. MARY: Castleton Gardens, alt. ca. 500 ft., on rocks above river, *Lewis*, 343.

ANAPTYCHIA LEUCOMELAENA (L.) Vain. MANCHESTER: Mandeville, on *Clusia* sp., *von der Porten*, 174,175. ST. ANDREW: John Crow Peak, near summit, alt. ca. 5700 ft., epiphytic in mossy forest, *Proctor* 3775. Summit cone, alt. 5500-5750 ft., on trees, *Farr*, 439. Cinchona Gardens, on *Podocarpus* sp., *Lewis*, 51. St. Helens Gap, alt. ca. 4750 ft., epiphytic on juniper trees, near edge of open cliff, *Proctor* 3719. St. Helens Gap to Morces Gap, on rock, *Lewis*, 26, fertile. Bellevue to New Haven Gap, on bank, *Lewis*, 77. ST. THOMAS: Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor* 5175. Fo. FILIFORMIS Dix. ST. THOMAS: Blue Mountain Peak, ridge between Sugar Loaf, alt. ca. 6600 ft., pendent epiphyte, *Proctor* 4345. Blue Mountain Peak, summit area, alt. ca. 7000-7400 ft., epiphyte in wet mossy forest, *Proctor* 4225. PORTLAND: Sugar Loaf Peak, alt. ca. 7000 ft., pendent epiphyte in mossy forest, *Proctor*, 4359.

ANAPTYCHIA OBSCURATA v. SOREDIATA Vain. ST. ANN: Mine area near Lydford P. O., alt. 1500 ft., wooded limestone hill, on wood, *Proctor*, 399.

ANTHRACOTHECIUM MUCOSUM (Vain.) Zahlbr. TRELAWNEY: Stonehenge near Kinloss, alt. 1250 ft., on bark of tree, *Farr*, 490.

ANTHRACOTHECIUM HIANS Müll. Arg. PORTLAND: Summit of Sugar Loaf Peak, alt. 7000 ft., on decaying log, *Farr*, 479.

ARTHONIA POLYMORPHA Ach. TRELAWNEY: Stonehenge near Kinloss, alt. 1250 ft., on bark of tree, *Farr*, 489.

ARTHONIA FEEANA Müll. Arg. GRAND CAYMAN: East End Inland, on mahogany, *Lewis*, 10.

BAEOMYCES ABSOLUTUS Tuck. ST. ANDREW: Mt. Airy, alt. 2500-3000 ft., on soil, *Farr*, 408, 409. New Haven Gap to Sir Johns Peak, alt. 5750-6332 ft., wet soil bank, *Farr*, 429. ST. THOMAS: W. slope of Blue Mt. Peak, alt. 6000-7000 ft., on clay banks, *Proctor*, 314.

BAEOMYCES ERYTHRELLUS (Mont.) Nyl. [*Heteromyces erythrellus* (Mont.) Nyl.] ST. ANDREW: Path from Mt. Airy to Tweedsdale, alt. 2000-2700 ft., on bank, *von der Porten*, 270. St. Helens Gap, alt. 4800 ft., on earth, *May Jeffrey-Smith*, 319.

BOMBYLIOSPORA DOMINGUENSIS (Pers.) Zahlbr. ST. ANDREW: Newcastle Road, near 17 mile post, alt. 3000 ft., on bark of log, *Farr*, 513.

CALENIA LEUCOTHRIX Vain. [*Echinoplaca epiphylla* Fée.] ST. ANDREW: Hope Gardens, alt. 600 ft., on dead leaf, *Farr*, 416, sterile.

CHIODECTON ANTILLARUM Vain. ST. ELIZABETH: Hollow behind Schoolhouse Hill, Quickstep, on *Annato-Bixa Orellana*, *von der Porten*, 225.

CHIODECTON CINERITUM (Ach.) Vain. Same data as for no. 225 above, 226. Sterile.

CHIODECTON SANGUINEUM (Sw.) Vain. MANCHESTER: Mandeville, on *Clusia*, *von der Porten*, 178. PORTLAND: Hardwar Gap to Waterfall, alt. 4000 ft., on bark of decaying log, *Farr*, 457. New Haven Gap trail, alt. 5000 ft., 1919, *C. C. Plitt*. ST. ANDREW: Cinchona Gardens, Blue Mts., on dead wood, *Lewis*, 56. ST. ELIZABETH: Path to Accompong from Quickstep, *von der Porten*, 232. ST. MARY: Castleton Gardens, alt. 496 ft., on palm (*Oreodoxa regia*), von der Porten, 207.

CLADONIA BALFOURI f. CHLOROPHAEOIDES (*Vain.*) Evans. ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten*, 211.

CLADONIA CALCYANTHA (Del.) Nyl. Bull Head, on earth, *Lewis*, 14.

CLADONIA CAPITATA (Mx.) Spreng. HANOVER: Near Cascade, alt. 1000 ft., on earth, *von der Porten*, 258. Var. ABBREVIATA (Vain.) Evans. Same data as for preceding. Fo. IMBRICATULA (Nyl.) Evans. MANCHESTER: Retford Pen, 3 mi. NW. of Hatfield P. O., alt. 2400 ft., on rock, *Dulcie Powell*, 438. All three specimens det. by Dodge.

CLADONIA CARTILAGINEA Müll. Arg. ST. ANDREW: Between Sir John and High Peak, Blue Mts., on wood, *Lewis*, 111.

CLADONIA CERATOPHYLLA (Sw.) Spreng. ST. ANDREW: Between Sir John and High Peak, Blue Mts., on bank, *Lewis*, 117. St. Helens Gap, on humus, *Lewis*, 44. Blue Mts., mossy forest, *Bengry*, 244, 250. Cinchona Gardens, alt. 4750 ft., on *Pinus massoniana*, *Lewis*, 65, 66. Vicinity of Cinchona, alt. ca. 4800 ft., LEWIS, 93. PORTLAND: W. slope of Portland Gap, alt. ca. 5000 ft., on open talus slide, *Proctor* 5314. ST. THOMAS: W. slope of Blue Mt. Peak, alt. 6000-7000 ft., on clay banks, *Proctor*, 298.

CLADONIA CHLOROPHAEA f. SIMPLEX (Hoffm.) Arn. ST. ANDREW: Cinchona Gardens, on earth, *von der Porten*, 17.

CLADONIA CONFUSA Santesson. Morces Gap Trail, 1919, *Seifriz*. ST. ANDREW: St. Helens Gap, on humus, *Lewis*, 37. St. Helens Gap to Morces Gap, on wood, *Lewis*, 40. Trail to Morces Gap, alt. 4750-4900 ft., *May Jeffrey-Smith*, 325.

CLADONIA CORALLIFERA (Kunze) Nyl. ST. ANDREW: Trail from Cinchona to Morces Gap, alt. 4750 ft., on soil bank, *Farr*, 428.

CLADONIA CORYMBITES Nyl. ST. THOMAS: Corn Puss Gap, near 8 mile post, alt. 2100 ft., on stone, *Bengry*, 256, det. Dodge.

CLADONIA DIDYMA (Fée) Vain. PORTLAND: Hardwar Gap to Green Hills, alt. 3500-4000 ft., on tree, *von der Porten*, 268. Summit of Sugar Loaf Peak, alt. 7000 ft., on trees, *Farr*, 454. ST. ANDREW: Above St. Helens Gap, on ground, *Bengry*, 246. Mossy forest between Sir John and High Peaks, on rotting wood, *Lewis*, 108b. ST. THOMAS: Corn Puss Gap, alt. 2100 ft., *Lewis*, 134. West slope of Blue Mt. Peak, alt. 6000-7000 ft., on clay banks, *Proctor*, 295. Fo. PYGMAEA Vain. ST. ANDREW: New Haven Gap, alt. 5750 ft., on tree, *Bengry*, 245. Fo. SQUAMULOSA Robbins. ST. THOMAS: Trail from Portland Gap to Blue Mt. Peak, alt. 5500-7400 ft., on rock, *Farr*, 354. Summit of East Peak (Lady Peak), alt. 7350-7375 ft., on trees and logs, *Farr*, 444. TRELAWNEY: Wilson Run District, ca. 5 mi. NW. of Troy, alt. 2000-2250 ft., on logs, *Veron Howard*, 418.

CLADONIA FIMBRIATA (L.) Fr. MANCHESTER: Retford Pen, 3 mi. NW. of Hatfield P. O., alt. 2400 ft., on rock, *Dulcie A. Powell*, 437.

CLADONIA FORMOSANA f. SUBLAEVIGATA Asahina. ST. ANDREW: Morces Gap, on soil, *Amy Barry (von der Porten)*, 22. Dr. Evans reports that this collection is of special interest as the only other collections of this species in the western world are two from Central America made by Sharp in 1945 and 1946.

CLADONIA FURCATA v. RACEMOSA (Hoffm.) Flk. Cinchona, 1919, *Scifriz*. ST. ANDREW: Newcastle, 3 mi. below, near Middletown, on bank, *Lewis*, 142. Bellevue slope-path to New Haven Gap, among moss on bank, *Lewis*, 75. ST. THOMAS: Corn Puss Gap, alt. 2100 ft., *Lewis*, 128.

CLADONIA GRAYI f. PROLIFERA Sandst. ST. THOMAS: Blue Mt. Peak, alt. 6000-7000 ft., on clay banks, *Proctor*, 294.

CLADONIA NANA Vain. ST. ANDREW: Path from Mt. Airy to Tweedsdale, alt. 2000-2500 ft., on bark, *von der Porten*, 271, det. Dodge. Sterile.

CLADONIA PITYREA v. ADSPERSA Vain. ST. ANDREW: Bellevue path to New Haven Gap, on bank, *Lewis*, 95. Trail from Cinchona to New Haven Gap, alt. 4750-5750 ft., *Lewis*, 105. Mossy forest between Sir John and High Peak, on bank, *Lewis*, 110. ST. THOMAS: Corn Puss Gap, on old ferns, *Amy Barry (von der Porten)*, 1, *Lewis*, 6. Between Portland and St. Thomas, on earth, *G. F. Asprey*, 172. Var. ZWACKHII f. SUBACUTA Vain. ST. THOMAS: Whitfield Hall, alt. 4000 ft., on rock ledges, *Proctor* 5172.

CLADONIA RAVENELII Tuck. ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten*, 212.

CLADONIA SANDSTEDEI des Abbayes. ST. ANDREW: Near St. Helens Gap, below Cinchona, *May Jeffrey-Smith*, 318. ST. MARY: 2-5 mi. S. of Longroad P. O., alt. 2500-3500 ft., forming tufts on open clay banks, *Proctor* 5447. ST. THOMAS: Summit of Blue Mt. Peak, alt. 7000-7400 ft., *Proctor*, 312.

CLADONIA SUBRANGIFORMIS Sandst. ST. ANDREW: Trail to Morces Gap, alt. 4750-4900 ft., *May Jeffrey-Smith*, 322. ST. THOMAS: High Peak, alt. 6800 ft., *Lewis*, 122.

CLADONIA WRIGHTII Evans. [*C. rangiformis* v. *cubana* Vain. *C. cubana* Evans.] PORTLAND: Summit of Sugar Loaf Peak, alt. 7000 ft., on trees, *Farr*, 452. ST. ANDREW: Mossy forest, above New Haven Gap, Blue Mt., on ground, *Bengry*, 243. Between Sir John and High Peaks, on rotting wood, *Lewis*, 108a. Bellevue slope path to New Haven Gap, *Lewis*, 73. ST. THOMAS: Vicinity of Portland Gap, alt. 5250 ft., on mossy bank, *Proctor*, 303. On trail from Portland Gap to Blue Mt. Peak, alt. 5500-7400 ft., on

rock, *Farr, 369.* (Evans notes that this specimen "differs chemically from *C. wrightii.*")

Coccocarpia cronia (Tuck.) Vain. St. Mary: Castleton Gardens, alt. 500 ft., on rocks above river, *Lewis,* 345. Var. prolificans (Malme) Dodge. St. Andrew: Cinchona Gardens, alt. 4750 ft., *Lewis,* 61.

Coccocarpia pellita v. lividorufa (Mey. & Fw.) Zahlbr. St. Thomas: Whitfield Hall, alt. ca. 4000 ft., on exposed rock ledges, *Proctor* 5182. Var. parmelioides (Hook.) Müll. Arg. St. Andrew: St. Helens Gap to Morces Gap, on rock, *Lewis, 27.* St. Mary: Castleton Gardens, alt. 496 ft., on palm with no. 215, *von der Porten,* 216. St. Thomas: Vicinity of Portland Gap, alt. 5250 ft., on shaded boulder, *Proctor,* 306. Var. pyrrichocarpa Hue. Clarendon: Peckham Woods, alt. 2500 ft., moist shaded limestone ledge, *Proctor,* 520.

Coenogium disjunctum Nyl. Portland: Trail from Waterfall to Caledonia Peak, alt. 4000-4500 ft., on rock, *Farr, 367.*

Coenogium interplexum Nyl. Portland: 1½ mi. SW. from Ecclesdown, east slope of John Crow Mts., alt. 1500-2000 ft., on moss, *Proctor,* 338.

Coenogium interponendum Nyl. St. Mary: Castleton Gardens, alt. 500 ft., on rocks above river, *Lewis,* 346. Trelawney: Slightly south of Barbecue Bottom, alt. 1300 ft., on soil bank, *Farr,* 422.

Coenogium interpositum Nyl. Hangver: Trail from Askenish Rock Foot to Dolphin Head, alt. 1300-1400 ft., on trees, *Farr,* 485. St. Andrew: ¼ mi. NW. of Newcastle, alt. 3900 ft., on rock, *Farr,* 371.

Coenogium leprierii v. panniforme Vain. St. Mary: Castleton Gardens, alt. 496 ft., on palm (*Oreodoxa regia*), *von der Porten, 203.*

Cora pavonia (Sw.) Fr. St. Andrew: Morces Gap, Cinchona, 1919, *Seifriz.* Bellevue, path to New Haven Gap, on soil, *Lewis,* 83. Portland: Sugar Loaf Peak, summit area, alt. ca. 7000 ft., epiphytic in mossy forest, *Proctor* 4364. Trelawney: Cockpit country ca. 8 mi. N. of Quickstep, above Aberdeen P. O., alt. ca. 1500 ft., epiphytic on upper branches of trees, *Proctor* 4147.

Dictyonema sericeum (Sw.) Berk. New Haven Gap, 1919, *Seifriz.* Portland: North slope of Portland Gap, alt. ca. 5000 ft., epiphytic, *Proctor* 5317. St. Ann: Mossy forest, New Haven Gap, Blue Mts., on tree with liverworts, *Lewis,* 107.

Erioderma microcarpum Riddle. St. Catherine: Sligoville, alt. 2000 ft., *von der Porten,* 195, sterile.

Graphis subamylacea Zahlbr. Grand Cayman: Top West Bay Beach, on dead breadfruit tree, *Lewis,* 8.

Gyalectidium filicinum Müll. Arg. St. Ann: Mt. Diabolo Forest Reserve, in pasture, ca. 2¼ mi. NW. of Schwallenburgh, alt. 2500 ft., on living bromeliad leaves, *Farr,* 484.

Heteromyces erythrellus (Mont.) Nyl. St. Andrew: Near St. Helens Gap, alt. 4800 ft., on earth, *May Jeffrey-Smith,* 319. Path from Mt. Airy to Tweedsdale, alt. 2000-2700 ft., on bank, *von der Porten,* 270.

Hypochnus peniophoroides Burt. St. Mary: Ca. 3 mi. E. of Clonmel P. O., alt. ca. 50 ft., *Farr,* 521.

Lasioloma arachnoideum (Krmph.) Santesson. St. Thomas: Bath Fountain, alt. ca. 500 ft., on dead leaf, *Farr,* 461.

Lecania sulphureofusca v. albidofusca (Vain.) Zahlbr. St. Thomas: Portland Gap to Blue Mt. Peak, alt. 5500-7400 ft., on wood, *Bengry,* 187.

Lecanora egranulosa Nyl. St. Thomas: Trail from Portland Gap to Blue Mt. Peak, alt. 5500-7400 ft., on bank, *Bengry.*

LECANORA SUBFUSCA v. MELANOCARPA Mont. ST. THOMAS: Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor* 5178.

LECIOGRAPHA MUSCIGENAE Rehm. ST. THOMAS: Summit of Blue Mt. Peak, alt. 7400 ft., *Proctor*, 292.

LEPTOGIUM INFLEXUM v. ISIDIOSULUM Nyl. ST. THOMAS: Near Portland Gap, alt. 5250 ft., on shaded boulder, *Proctor*, 304.

LEPTOGIUM MARGINELLUM (Sw.) Gray. ST. ANDREW: Marydown Guest House, near Newcastle, alt. ca. 3500 ft., on trail bank, *von der Porten*, 269. TRELAWNEY: Stonehenge, ca. 2 mi. S. of Kinloss, alt. 1250 ft., on trees, *Farr*, 421.

LEPTOGIUM MOLUCCANUM (Pers.) Vain. [*L. diaphanum* (Sw.) Mont.] PORTLAND: Road from Hardwar Gap to Green Hills, alt. ca. 4000 ft., on sloping hillside bank, *von der Porten*, 266. ST. ANDREW: Slope of Sir John Peak, on bank with no. 119, *Lewis*, 118a. New Haven Gap, on tree, *Lewis*, 35. Bellevue slope path to New Haven Gap, *Lewis*, 79.

LEPTOGIUM OLIVACEUM (Hook.) Zahlbr. [*L. foveolatum* Nyl.] ST. ANDREW: Rose Hill Wood, alt. 4250 ft., *Bengry*, 393.

LEPTOGIUM PAPILLOSUM (B. de Lesd.) Dodge. ST. ANDREW: Vicinity of Hermitage Dam, alt. ca. 1700 ft., on mossy rock, *Proctor* 4992.

LEPTOGIUM PHYLLOCARPUM (Pers.) Mont. ST. ANDREW: Morces Gap, on wood, *I. Miller*, 248. Mossy forest, above New Haven Gap, among moss, *Bengry*, 249. Var. MACROCARPUM Nyl. ST. ANDREW: New Haven Gap, alt. 5750 ft., on rotten stump, *Farr*, 433. Var. CORALLIDEUM (Mey. & Fw.) Hue. ST. ANDREW: Trail to Morces Gap, alt. 4750-4900 ft., *May Jeffrey-Smith*, 327.

LEPTOGIUM STIPITATUM Vain. PORTLAND: Middle eastern slope of John Crow Mts., ca. 2¼ mi. SW. of Ecclesdown, alt. 2000-3000 ft., on tree trunks, *Proctor*, 5724.

LEPTOGIUM TREMELLOIDES v. AZUREUM (Sw.) Nyl. [*L. azureum* (Sw.) Mont.] PORTLAND: Valley of the Back Rio Grande, ca. 3 mi. SW. of Fellowship P. O., on shaded tree trunk, *Proctor*, 5020. 2 mi. SW. of Ecclesdown, alt. 2250 ft., on rock, *Farr*, 468. ST. ANDREW: Bellevue slope—path to New Haven Gap, on banks, *Lewis*, 79. Hermitage Dam, alt. 1750 ft., on tree, *Lewis*, 255. Trail to Morces Gap, *May Jeffrey-Smith*, 326. Slope of Sir John Peak, with no. 119, *Lewis*, 118b. ST. ELIZABETH: Quickstep, hollow behind School-house Hill, on *Annato-Bixa Orellana*, *von der Porten*, 224. ST. MARY: Castleton Gardens, alt. 500 ft., on rocks above river, *Lewis*, 345. ST. THOMAS: Trail south from Corn Puss Gap toward Bath, on shaded boulder, *Proctor*, 3883.

LEPTOTREMA BAHAIANUM (Ach.) Müll. Arg. CLARENDON: Upper north slope of Round Hill, alt. 500-1000 ft., on *Dipholis* bark, *Proctor*, 522.

LEPTOTREMA POLYCARPUM v. AMERICANUM Redgr. ST. ANDREW: Stanton Terrace, Mountain View Gardens, on veranda, *Lewis*, 144a.

LOBARIA CRENULATA (Hook.) Trev. ST. THOMAS: Vicinity of Portland Gap, alt. 5250 ft., on twigs, *Proctor*, 302. Whitfield Hall, alt. ca. 4000 ft., adhering to tree trunks, *Proctor*, 5185.

LOBARIA DISSECTA (Sw.) Räuschl. [*L. corrosa* Ach.] Cinchona, 1919, *Seifriz*. PORTLAND: N. slope of Portland Gap, alt. ca. 5000 ft., on tree trunks, *Proctor* 5135. ST. ANDREW: High Peak, on wood, *Lewis*, 126, 127. On trail from Clydesdale to Morces Gap, alt. 3500-4900 ft., on soil, *Farr*, 362, 364. Bellevue slope-path to New Haven Gap, on bark, *Lewis*, 80, 82. Rose Hill Wood, alt. 4250 ft., *Bengry*, 391, 392. ST. THOMAS: Corn Puss Gap, on wood, *Lewis*, 237. Trail from Portland Gap to Blue Mt. Peak, alt.

6000-7000 ft., epiphytic in moist forest, *Proctor*, 4388. Vicinity of Portland Gap, on shaded boulder, alt. 5250 ft., *Proctor*, 307.

LOBARIA QUERCIZANS (Ach.) Mx. [*L. crosa* (Esch.) Trev.] ST. ANDREW: Trail from New Haven Gap to Sir John Peak, alt. 5750-6332 ft., on logs and stumps, *Farr*, 430.

LOBARIA PELTIGERA (Del.) Vain. Sligoville, on wood, *von der Porten*, 196. Morces Gap, *von der Porten*, 21. ST. THOMAS: High Peak, alt. 6800 ft., *Lewis*, 125.

LOBARIA SUBCORROSA (Nyl.) Vain. ST. ANDREW: Mona, alt. ca. 650 ft., on boulders, *E. B. Martyn*, 222.

LOPADIUM LEUCOXANTHUM (Spreng.) Zahlbr. ST. MARY: Castleton Gardens, alt. 496 ft., on tree, *von der Porten*, 213.

LOPADIUM PERPALLIDUM (Nyl.) Zahlbr. TRELAWNY: Troy, alt. 1500 ft., on bark of lime tree, *Farr*, 423.

MAZOSIA ROTULA (Mont.) Mass. ST. ANDREW: Summit of Coopers Hill, alt. 2550 ft., on living leaves, *Farr*, 477.

OCELLULARIA CINCHONARUM (Fée) Spreng. ST. THOMAS: West slope of Blue Mt. Peak, alt. 6500-7000 ft., on bark of tree, *Proctor*, 330.

OCELLULARIA CLANDESTINA (Ach.) Müll. Arg. HANOVER: Summit of Dolphin Head, alt. 1780 ft., at base of tree, *Farr*, 486.

OCELLULARIA MYRIOPORA (Tuck) Müll. Arg. TRELAWNEY: Wilson Run District, ca. 3 mi. NW. of Troy, on trees, *Farr*, 419.

OCELLULARIA TERREBRATA (Ach.) Müll. Arg. ST. ANDREW: Summit of Coopers Hill, alt. 2550 ft., on trees, *Farr*, 481.

PANNARIA MALMEI Dodge. ST. ANDREW: Cinchona Gardens, on *Yucca podocarpus*, *Lewis*, 52b.

PANNARIA MARIANNA (Fr.) Müll. Arg. ST. ANDREW: Mossy forest, New Haven Gap, on tree, *Lewis*, 106.

PANNARIA MOSENI Dodge. ST. ANN: On wooded limestone hill in mine area, near Lydford P. O., alt. 1500 ft., on wood, *Proctor*, 400.

PANNARIA RADIATA (Vain) Dodge. ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten*, 208.

PANNARIA STYLOPHORA Vain. PORTLAND: Summit of Sugar Loaf Peak, alt. 7000 ft., on trees, *Farr*, 455. ST. MARY: Castleton Gardens, alt. 496 ft., on palm (*Oreodoxa regia*), *von der Porten*, 205.

PARMELIA AMAZONICA V. HUSNOTII Hue. ST. THOMAS: Trail from Portland Gap to Blue Mt. Peak, alt. 5500-7400 ft., on wood, *Bengry*, 188.

PARMELIA BLASTICA Vain. "Jamaica," 1847, *Jacob Wolle* (T. C. Porter Collection). CLARENDON: Bull Head, alt. 2780 ft., on tree, *Bengry*, 334. ST. ANDREW: Shaded ravine on east slope of Jacks Hill, above Cooperage, alt. ca. 1350 ft., adhering to boulder, *Proctor*, 5188.

PARMELIA CAPITATA Lynge. ST. MARY: Castleton Gardens, alt. 500 ft., on rocks above river, *Lewis*, 347.

PARMELIA CETRATA Ach. ST. ANDREW: Cinchona Gardens, on *Pinus massoniana*, *Lewis*, 70.

PARMELIA CIRRHATA Fr. [*P. vermicularis* Vain.] PORTLAND: Summit of Sugar Loaf Peak, alt. ca. 7000 ft., on trees, *Farr*, 451.

PARMELIA CONFORMATA Vain. ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten*, 215.

PARMELIA CRISTIFERA Tayl. Same data as for no. 215 above, 214.

PARMELIA CUBENSIS Nyl. ST. ANDREW: Cinchona Gardens, alt. 4750 ft., on *Pinus massoniana*, *Lewis*, 67. High Peak, alt. 6400-6800 ft., *Lewis*, 124.

PARMELIA DOMINICANA Vain. GRAND CAYMAN: East End Inland, on orange, *Lewis*, 12.

PARMELIA JAMAICENSIS Vain. ST. ANDREW: Mossy forest above New Haven Gap, on wood, *Bengry*, 240. ST. THOMAS: Whitfield Hall, alt. 4000 ft., adhering to exposed rock ledges, *Proctor*, 5173.

PARMELIA LATISSIMA Fée. GRAND CAYMAN: East End Inland, on orange, *Lewis*, 11. ST. ANN: On wooded limestone hill in mine area near Lydford P.O., alt. 1500 ft., on wood, *Proctor*, 403. ST. ANDREW: Newcastle Road, between 9 and 10 mile posts, alt. 2500 ft., on bark of log, *Farr*, 517. ST. MARY: Castleton Gardens, alt. ca. 500 ft., on rocks above river, *Lewis*, 344. On palm, *von der Porten*, 218a, b, 220. NE. slope of Cum See Hill, above Longroad P. O., alt. 1000-2000 ft., on bark, *Proctor*, 5372.

PARMELIA RETICULATA Tayl. [*P. cetrata* v. *sorediifera* Vain.] ST. ANDREW: Cinchona Gardens, alt. 4750 ft., on *Yucca podocarpus*, *Lewis*, 52a, on *Pinus massoniana*, *Lewis*, 68.

PARMELIA SUBCRINITA Nyl. [*P. mauriensis* v. *sorediifera* Vain.] ST. THOMAS: Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor*, 5176.

PARMELIA SULPHURATA Nees & Fw. ST. CATHERINE: Juan de Bolas District, W. of Point Hill, alt. 2400-2700 ft., *Proctor*, 287. TRELAWNEY: Woodlands 1 mi. NW. of Stewart Town, alt. 1000 ft., on log, *Lena Pierce*, 510.

PARMELIA TINCTORUM Despr. [*P. coralloidea* Vain.] ST. ANDREW: Hermitage Reservoir, alt. 1750 ft., on tree, *Farr*, 507. Var. FLAVICANS (Müll. Arg.) Zahlbr. [P. *practervisa* v. *flavicans* Müll. Arg.] ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten*, 198.

PARMELIA XANTHINA (Stzbgr.) Vain. ST. ANDREW: Between Sir John Peak and High Peak, alt. 6330-6800 ft., *Lewis*, 112.

PARMELIELLA PANNOSA (Sw.) Müll. Arg. ST. ANDREW: New Haven Gap, on trees, *Lewis*, 36 ("an extreme microphylline form," Dodge). ST. THOMAS: Blue Mt. Peak, summit area, in forest, alt. 700-7400 ft., epiphytic, *Proctor*, 4221.

PELTIGERA AUSTROAMERICANA Zahlbr. [*P. americana* Vain.] ST. ANDREW: Hardwar Gap, on bank, *von der Porten*, 262.

PELTIGERA DOLICHORRHIZA Nyl. PORTLAND: Along driving road from Hardwar Gap to Green Hills, alt. 3500-4000 ft., on sloping hillside, *von der Porten*, 264. ST. ANDREW: Mossy forest above New Haven Gap, on ground, *Bengry*, 239, *Lewis*, 101. Slope of Sir John Peak, on bank, *Lewis*, 119. St. Helens Gap to Morces Gap, on humus, *Lewis*, 21. Trail to New Haven Gap, alt. 4750-5750 ft., on humus, *von der Porten*, 164. Near St. Helens Gap, alt. 4800 ft., *May Jeffrey-Smith*, 321. ST. THOMAS: Vicinity of Portland Gap, alt. 5250 ft., on shaded boulder, *Proctor*, 305. On trail from Portland Gap to Morces Gap, alt. 5500-7400 ft., on bank, *Bengry*, 181.

PELTIGERA ERIODERMA Vain. ST. ANDREW: St. Helens Gap, on flat open ground, *Lewis*, 41.

PELTIGERA LACINIATA (Merr.) Gyeln. ST. ANDREW: St. Helens Gap to Morces Gap, on ground and rock, *Lewis*, 39, 41. Hardwar Gap, alt. 4000 ft., on rock, *Farr*, 342.

PELTIGERA GRAULATA (Ach.) Müll. Arg. ST. ANDREW: Morces Gap, alt. 4900 ft., on wood, *Amy Barry* (*von der Porten*), 378. Fo. SOREDIATA (Fée) Zahlbr. PORTLAND: 2 mi. SW. of Ecclesdown, alt. 2250 ft., Farr, 471. ST. ANDREW: Newcastle Road at spring near 17 mi. post, on bark of log, *Farr*, 516. ST. THOMAS: Bath Fountain, alt. ca. 500 ft., *Farr*, 466.

PHAEOGRAPHIS CINNABARINA (Fée) Müll. Arg. ST. ELIZABETH: Quickstep, hollow behind School-house Hill, on *Annato-Bixa Orellana, von der Porten,* 229.

PHAEOTREMA FUSCESCENS (Krmph.) Zahlbr. ST. ANDREW: Upper Mountain View. Stanton Terrace, alt. ca. 350 ft., on veranda, *Lewis,* 144.

PHYLLOPHIALE ALBA Santesson. ST. ANDREW: Summit of Coopers Hill, alt. 2550 ft., on living leaves, *Farr,* 478.

PHYSCIA AGGLUTINATA Nyl. ST. MARY: Clermont, east of Highgate, alt. 1000 ft., on bark of coconut palm, *Proctor* 5771.

PHYSCIA ENDOCHRYSEA (Nyl.) Hampe. ST. THOMAS: Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor* 5179.

PHYSCIA MINOR (Fée) Vain. MANCHESTER: Mandeville, alt. 2000 ft., on *Clusia* sp., *von der Porten,* 179.

PSEUDOCYPHELLARIA AURATA (Ach.) Vain. [*Sticta aurata* Ach.] ST. THOMAS: Near Whitfield Hall, alt. 4100 ft., on tree, *Farr,* 357. Same locality, adhering to tree trunks, *Proctor* 5184. West slope of Blue Mt. Peak, alt. 6000-7000 ft., on trail bank, *Farr,* 358.

Pseudocyphellaria rugulosa (Tayl.) comb. nov. *Sticta rugulosa* Tayl. *in* Hook., London Jour. Bot. 7: 177. 1847. Dodge writes that Zahlbruckner erroneously placed *Sticta rugulosa* Tayl. as a synonym of *Everniopsis trulla* Nyl. ST. ANDREW: New Haven Gap, alt. 5750 ft., *Lewis,* 32.

PSEUDOCYPHELLARIA XANTHOLOMA (Del.) Dodge. ST. THOMAS: Summit of Blue Mt. Peak, alt. 6000-7000 ft., on clay bank, *Proctor,* 300.

PSEUDOPYRENULA (Sect. Hemithecium) sp. nov.? ST. ELIZABETH: Quickstep, hollow behind School-house Hill, on *Annato-Bixa Orellana, von der Porten,* 230. Spores hyaline, 4-septate, ca. 8 × 20 μ, uniseriate. ("Differs from previously described species of this section in spore size and uniseriate spores," Dodge.)

PYXINE CHRYSANTHOIDES Vain. ST. ANDREW: Near Charlottenburg, alt. 3500 ft., *Proctor,* 282.

PYXINE COCOES f. ISIDIOPHORA Müll. Arg. ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten,* 209.

RAMALINA ATTENUATA (Pers.) H. Howe, Jr. [*R. rigida* Ach.] ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten,* 219.

RAMALINA COMPLANATA (Sw.) Ach. CLARENDON: 1 mi. SW. of Jacksons Bay, on cactus, *Lewis,* 335.

RAMALINA CUMANENSIS Fée. ST. ANDREW: Cinchona Gardens, *von der Porten,* 167.

RAMALINA HYPODECTODES Nyl. CLARENDON: Bull Head, alt. 2780 ft., on tree, *Bengry,* 332.

RAMALINA LANCEOLATA v. PROLIFERA (Tayl.) Zahlbr. [*R. membranacea* Mont.] ST. ANDREW: Bellevue, S. of Guava Ridge, alt. 3750 ft., on tree trunk, *von der Porten,* 272. Chester Vale, Blue Mts., on fence posts, *von der Porten,* 169.

RAMALINA LINEARIS (Sw.) Ach. Cinchona, 1919, *Seifriz.*

RAMALINA SINTENISII Müll. Arg. CLARENDON: 1 mi. SE. of Jackson, *Lewis,* 335. Var. POLYCLADA Müll. Arg. Chester Vale, Blue Mts., on fence posts, *von der Porten,* 169.

RAMALINA SOREDIANTHA Nyl. TRELAWNEY: Woodlands near Westwood, 1 mi. NW. of Stewart Town, alt. 1000 ft. on log, *Lena Pierce,* 511. ST. ANN: Crescent Park, near Lydford P. O., alt. 1500 ft., on bark, *Proctor,* 426.

RAMALINA SPECIOSA (Müll. Arg.) Vain. ST. ANDREW: Cinchona Gardens, on tree trunk, *Lewis,* 53.

RAMALINA SUBFRAXINEA Nyl. Blue Mts., Chester Vale, on fence posts, *von der Porten*, 169.

RAMALINA SUBPELLUCIDA Müll. Arg. WESTMORELAND: Blauwearie, alt. 500-1000 ft., on rotten wood over limestone, *Proctor*, 331. Var. TUBERCULATA Müll. Arg. NORTH CAICOS: Vicinity of Kew, in dense woods, on shaded tree trunks, *Proctor*, 405.

RAMALINA USNEA V. USNEOIDELLA (Nyl.) H. Howe, Jr. ST. MARY: Castleton Gardens, on tree trunk, *Amy Barry* (*von der Porten*), 141.

SCYTONEMA HOFMANNII Ag. Lindo's Gap, limestone rock, *Trevor Martin*, 234.

SCYTONEMA MILLEI Bornet. ST. ANDREW: Golden Spring, near Stony Hill, alt. ca. 1000 ft., on ground, *Lewis*, 143.

SCYTONEMA STUPOSUM (Kütz.) Bornet. ST. ANDREW: Summit of Coopers Hill, alt. 2550 ft., on limestone, *Farr*, 176. ST. THOMAS: Bath Fountain, alt. ca. 500 ft., *Farr*, 459.

SPHAEROPHORUS MELANOCARPUS (Sw.) DC. Summit of Blue Mt. Peak, 1919, *Seifriz*. Same area, alt. ca. 7375 ft., terrestrial, on mossy bank, *Proctor*, 4323, 7084.

SPOROPODIUM PHYLLOCHARIS (Mont.) Mass. Irwin, leaf of citrus, *E. B. Martyn*, 197.

STEREOCAULON CORNUTUM Müll. Arg. ST. ANDREW: Morces Gap Trail, near Cinchona, 1919, *Seifriz*. St. Helens Gap to Morces Gap, on rocks, *Lewis*, 22, 24. ST. THOMAS: Ca. 1 mi. below summit of Blue Mt. Peak, alt. 6000-7000 ft., on trail bank, *Farr*, 359. West slope of Blue Mt. Peak, alt. 6000-7000 ft., on clay banks, *Proctor*, 299. SE. slope of Mossmans Peak, alt. 5500-6700 ft., on wet decaying log, *Farr*, 386. Blue Mt. Peak, summit area, alt. 7400 ft., on open ground or earth banks, common, *Proctor* 4220.

STEREOCAULON RAMULOSUM (Sw.) Rausch. ST. ANDREW: On trail from Cinchona to Morces Gap, alt. 4750-4900 ft., on wet rock, *Farr*, 432. Between Cinchona and St. Helens Gap, alt. 4800 ft., *May Jeffrey-Smith*, 317. On trail from Clydesdale to Morces Gap, alt. 3500-4900 ft., *Farr*, 361. ST. THOMAS: Summit area of Blue Mt. Peak, alt. 7000-7400 ft., *Proctor*, 309.

STICTA ANDENSIS V. MELANOCARPA (Müll. Arg.) Zahlbr. PORTLAND: Summit of Sugar Loaf Peak, alt. 7000 ft., on trees, *Farr*, 456.

STICTA ANTILLARUM Vain. PORTLAND: N. slope of Portland Gap, alt. 5000 ft., on open talus slide, *Proctor*, 5311. ST. ANDREW: Trail from St. Helens Gap to Morces Gap, on wood, *Lewis*, 15, 16.

STICTA DAMAECORNIS (Sw.) Ach. Cinchona, 1919, *Seifriz*. PORTLAND: Blue Mt. Peak, north slope of summit area, alt. ca. 7250 ft., epiphyte in mossy forest, *Proctor*, 4384. 10 mi. SW. of Priestmans River, on trees, *Proctor*, 375. ST. ANDREW: On trail to New Haven Gap, alt. 4750-5750 ft., *Lewis*, 85. Bellevue, path to New Haven Gap, on bank, *Lewis*, 97. Mossy forest, New Haven Gap, on bank, *Lewis*, 98. Near Content Gap, alt. 3250 ft., on shaded bank, *Leaford Patrick*, 276. St. Helens Gap to Morces Gap, on wood, *Lewis*, 20. ST. THOMAS: Hibernia Hill, upper valley of Green River, alt. 4000 ft., on tree trunks in deep shade, *Proctor* 5547. Var. ELONGATOLACINIATA Tuck. PORTLAND: On road from Hardwar Gap to Green Hills, alt. ca. 4000 ft., *von der Porten*, 267. Var. DENUDATA Nyl. PORTLAND: Summit of Sugar Loaf Peak, alt. 7000 ft., on trees and decaying log, *Farr*, 450. Crown Peak, John Crow Mts., alt. 3700 ft., on tree trunks, *Grady L. Webster*, 397. Var. SUBDAMAECORNIS Müll. Arg. ST. THOMAS: Summit of East Peak (Lady Peak), alt. 7350-7375 ft., on logs and trees, *Farr*, 447.

STICTA DAMAECORNIFOLIA Vain. ST. ANDREW: On ridge E. of John Crow

Peak, alt. 5000-5200 ft., on trees, *Farr*, 435. ST. THOMAS: Corn Puss Gap, on wood, *Lewis*, 238.

STICTA GLOMULIGERA Nyl. ST. THOMAS: Vicinity of Portland Gap, alt. ca. 5300 ft., on shaded boulder, *Proctor*, 308.

STICTA SATURNINA Meisn. PORTLAND: 10 mi. SW. of Priestmans Gap, on trees, *Proctor*, 376.

STICTA TOMENTOSA (Sw.) Ach. ST. ANDREW: New Haven Gap trail, on humus, *von der Porten*, 162. ST. THOMAS: Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor* 5174. Var. L'HERMINIERI (Nyl.) Zahlbr. ST. ANDREW: St. Helens Gap, on humus, *Lewis*, 37. ST. THOMAS: 1-2 mi. below Portland Gap, *alt.* 4300-5500 ft., on rock, *Farr*, 355.

STICTA VARIABILIS (Bory) Ach. [*Sticta propaginea* Tayl.] ST. ANDREW: On trail to Morces Gap, alt. 5750-4900 ft., *May Jeffrey-Smith*, 324.

STICTA WEIGELII (Ach.) Isert. JAMAICA, *Jacob Wolle*, 1847. (T. C. Porter Collection.) HANOVER: Near Cascade, alt. ca. 1000 ft., on rock, *von der Porten*, 257. ST. ANDREW: ¼ mi. NW. of Newcastle, on rock, *Farr*, 394. Near Charlottenburg, alt. 3500 ft., *Proctor*, 283. St. Helens Gap to Morces Gap, on humus with liverworts, *Lewis*, 19. Newcastle Road, between 16 and 17 mi. posts, alt. ca. 3000 ft., on mesic rock, *Farr*, 341. St. Helens Gap, on wood, *Lewis*, 40. Trail from Cinchona to Morces Gap, alt. 4750-4900 ft., on soil bank, *Farr*, 427. ST. THOMAS: Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor*, 5177. TRELAWNEY: Cockpit country, ca. 8 mi. N. of Quickstep, above Aberdeen P. O., alt. ca. 1500 ft., epiphytic on upper branches of huge forest trees, *Proctor*, 4148. Var. BEAUVOISII (Del.) Hue. ST. ANDREW: Trail to Morces Gap, alt. 4750-4900 ft., *May Jeffrey-Smith*, 328. Var. SCHIZOPHYLLIZA. (Nyl.) Hue. PORTLAND: 10 mi. SW. of Priestmans River, *Proctor*, 374. ST. ANDREW: Near St. Helens Gap, alt. 4800 ft., *May Jeffrey-Smith*, 321. Bellevue slope—path to New Haven Gap, on banks with moss, *Lewis*, 77, 18. Var. LEUCOBLEPHARA (Müll. Arg.) Zahlbr. ST. ANDREW: Mossy forest, New Haven Gap, on bank, *Lewis*, 103. ST. MARY: Castleton Gardens, alt. 496 ft., on palm, *von der Porten*, 217.

STIRTONIA sp. ST. ANDREW: Stanton Terrace, Mountain View Gardens, on veranda, *Lewis*, 144b.

STRIGULA ELEGANS (Fée) Müll. Arg. MANCHESTER: Shooters Hill, 1½-2 mi. S. of Mizpah, alt. 1400 ft., on dead leaf, *Farr*, 425. ST. THOMAS: Bath Fountain, alt. ca. 500 ft., on dead leaf, *Farr*, 473, 462. CLARENDON: N. slope of Round Hill, alt. 500-1100 ft., on leaves of *Proctor*, 9494, *Proctor*, 441.

TELOSCHISTES FLAVICANS (Sw.) Müll. Arg. CLARENDON: Bull Head, alt. 2782 ft., on twigs, *Bengry*, 415. MANCHESTER: Mandeville, alt. 2000 ft., on *Clusia* sp., *von der Porten*, 176. ST. ANDREW: Cinchona Gardens, *Lewis*, 54. ST. THOMAS: Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor*, 5171.

THELOTREMA ANNULATUM Müll. Arg. HANOVER: Dolphin Head, alt. 1000-1700 ft., on base of tree trunk, *Proctor*, 372.

THELOTREMA PRAESTANS Müll. Arg. ST. ELIZABETH: Hollow behind School-house Hill, Quickstep, on *Annato-Bixa Orellana*, *von der Porten*, 231.

TRICHARIA VULGARIS (Müll. Arg.) Santesson. ST. THOMAS: Bath Fountain, alt. ca. 500 ft., on dead leaf, *Farr*, 465.

TRYPETHELIUM LEPROSUM Müll. Arg. Providenciales, West Harbor, on logs and twigs, *Proctor*, 377.

USNEA CLADOCARPA Fée. PORTLAND: N. slope of Portland Gap, alt. 5000 ft., epiphytic, *Proctor*, 5316.

USNEA FURFUROSULA (Zahlbr.) Motyka. ST. CATHERINE: Juan de Bolas district, W. of Point Hill, alt. 2400-2700 ft., Proctor, 289.

USNEA LEUCOXANTHA Motyka. ST. ANDREW: Cinchona Gardens, in wood with *Teloschistes flavicans*, *Lewis*, 54, 55. Mossy forest, above New Haven Gap, *Bengry*, 247.

USNEA JAMAICENSIS (Lam.) Ach. ST. THOMAS: Vicinity of Portland Gap, alt. 5250 ft., on twigs, *Proctor*, 313.

USNEA JELSKII Motyka. Bull Head, on wood, *Lewis*, 13a.

USNEA LESDAINII Motyka. ST. ANDREW: On trail from Clydesdale to Morces Gap, alt. 3500-4900 ft., on log, *Farr*, 514.

USNEA RUBICUNDA Stirton. ST. THOMAS: Whitfield Hall, alt. ca. 4000 ft., adhering to exposed rock ledges, *Proctor* 5170. High Peak, Blue Mts., on wood, hanging from trees, *Lewis*, 123. Blue Mt. Peak, *Seifriz*, 1919. I have assigned the latter specimen here with some hesitation, as it has some characteristics that do not fit any of the varieties proposed by Motyka (1936-38). A description follows: thallus somewhat curved, about 1 dm. long, diameter 500 μ, axis ca. 175 μ, regularly articulate, articulations ca. 1-1.25 mm., branches few or none, esorediose, K−.

USNEA SERICEA Motyka. ST. ANDREW: Charlottenburg, alt. 3500 ft., *May Jeffrey-Smith*, 475.

USNEA SETULOSA Motyka. ST. ANDREW: Summit of Coopers Hill, alt. 2550 ft., on stump, *Farr*, 480.

USNEA SUBHIRTA (Vain.) Motyka. ST. ANDREW: Cinchona Gardens, *Lewis*, 54 p. p.

LICHENES IMPERFECTI. "A new genus near *Campylidium*," Dodge. ST. ELIZABETH: Trail to Accompong from Quickstep, on Pepper-leaved Sweetwood (*Misanteca triandra*), *von der Porten*, 233.

LITERATURE CITED

BROWNE, P. 1756. The Civil and Natural History of Jamaica . . . viii + 503 *pp.* 1 *map.* 49 *pl.* London.

EVANS, A. W. 1955. Notes on North American *Cladoniae*. THE BRYOLOGIST 58: 93-112.

FÉE, A. L. A. 1824. Essai sur les Cryptogames des Ecores exotiques officinales, précédé d'un Méthode Lichénographique . . . civ + 167 *pp.* 34 *pl.* Paris.

HOWE, H., JR. 1914. On a small collection of lichens of Jamaica, West Indies. Mycologia 6: 260-263.

MOTYKA, J. 1936-38. Lichenum generis Usnea studium monographicum. Pars systematica. Vol. 1-2, 651 *pp.* Leopoli.

PLITT, C. C. 1921. A preliminary report, with notes, on lichens found near Cinchona Botanical Station, Jamaica, British West Indies. THE BRYOLOGIST 24: 60-64, 70-74.

RIDDLE, L. 1912. An enumeration of lichens collected by Clara Eaton Cummings in Jamaica. Mycologia 4: 125-140.

———. 1917. Some noteworthy lichens from Jamaica. Bull. Torrey Bot. Club 44: 321-330.

SLOANE, H. 1707. A Voyage to the Islands Madera, Barbados, Nieves, St. Christophers and Jamaica with natural history . . . of the last of those islands . . . Vol. 1. cliv + 264 *pp.* 156 *pl.* 1 *map.* London.

WAINIO, E. A. 1915. Additamenta ad lichenographiam antillarum illustrandam. Ann. Acad. Sci. Fenn. Ser. A, 6(7): 1-214.

REVIEWS

SIGFRID ARNELL: *Illustrated Moss Flora of Fennoscandia. I. Hepaticae.* Edited by The Botanical Society of Lund. *308 pp. Fig.* 1-98. 1 *folding map insert.* C. W. K. Gleerup, Lund. [35 Swedish Crowns.]—Several excellent treatises on the liverworts of Scandinavia and Finland are available, in various languages, but this manual with keys and descriptions carefully prepared in English will be greatly appreciated in North America because of the wide northern distributions of many Fennoscandian species and will no doubt be very useful to bryologists of the Scandinavian countries where English appears to be more generally understood than Finnish, for example. The book is well printed on a good grade of paper, copiously illustrated and attractively bound in stiff paper.

The author disclaims originality, and his work can only be judged, favorably I think, for what it is—a compilation of works by H. W. Arnell in Swedish, C. Jensen in Danish and Hans Buch in Finnish. Distributional data have been taken from the literature and from specimens in various herbaria without close examination except in the case of more startling records. Thus, detailed statements of ranges are not necessarily reliable, but the author has surely had a wealth of experience with the flora and could doubtless avoid gross errors of this kind.

The illustrations are, for the most part, borrowed from other authors, particularly Buch, K. Müller and Macvicar; relatively few are original. They thus differ in style, quality and details. Some are extremely simple and rather unattractive, but useful. A glossary of terms and an introductory essay on methods of collection and study are provided.—H. A. CRUM.

HENRY S. CONARD: *How to Know the Mosses and Liverworts. Pictured keys for determining many of the North American mosses and liverworts, with suggestions for their study.* Revised edition. x + *226 pp. Fig.* 1-442. 3 *photographs and 6 cuts (unnumbered).* Wm. C. Brown, Dubuque, Iowa. [Spiral, $2.50; cloth, $3.00.]—This is an excellent handbook for students or amateurs who have the use of a microscope. It is a great improvement over the first edition of 1944, not only because it has been expanded to include the liverworts, but also because many of the rough spots have been ironed out. For example, the 13th dichotomy in the key is no longer unlucky; in fact, it is not even necessary to make the difficult choice between the Haplolepideae and the Diplolepideae. Also, *Dicranoweisia cirrhata* is no longer listed in the index as *D. serrata.*

As before, the illustrations are well executed, mostly by (Mrs.) Louisa Sargent Conard, and the keys are clearly written. The introductory essays on what mosses are, where they grow and how to study them are written in an easy and charming style. The illustrated glossary is a gem.

I have little criticism of the keys, except that they are not always dichotomous; three choices are often given. I find that, particularly in long keys, one tends to miss the third choice and get hopelessly lost. I do question the value of using such terms as phaneropore, Haplolepideae, pseudopodium, acrocarpous, lamina and hypophysis in a book which, to judge by the cartoon on page vi, is intended even for children. The little girl shown there may look up the beautiful moss in her book, but she won't find it until about 12 years later when she has acquired a microscope and some facility with bryological jargon. By that time, she may not be amused by the cartoon on page 8 ("Mrs. Liverwort, Here are some of my children") or that on page 16 ("Moses with a Hand-lens").

It is true that technical terms are mostly used as alternates and are well explained, but many of them are quite unnecessary in a book of this sort. I rarely think in terms of the Nematodonteae and *never* of the Atracheata. Why burden a book of such genuinely popular appeal with needless mouth-filling words, when even the concepts, in some cases, have little to do with the means of identification? Except for the avowed purpose of this book, the terminology would not come under fire, and I would be equally crusty perhaps over a more technical work in which phyllidium, phyllode or phylloid are substituted for leaf, regardless of the excellence of the morphological reasoning behind such special terms. It is equally tiresome, I think, to refer to the belly of a dog as ventral but at the same time call the upper side of a leaf and the lower side of a thallose liverwort as ventral. Why not say simply upper and lower sides, or even adaxial and abaxial, if it seems necessary, and avoid the confusion?—H. A. Crum.

Walter H. Snell & Esther A. Dick, with illustrations by Henry A. C. Jackson: *A Glossary of Mycology*. 171 *pp.* 15 *pls.* 192 *fig.* Harvard University Press, Cambridge, Mass. March 28, 1957. ($5.00).—Approximately 7000 terms of mycological importance and/or interest are clearly and concisely defined in this very useful reference book for amateur, professional and industrial mycologists. The *Glossary of Mycology* should be a companion volume to regular and botanical dictionaries because it thoroughly covers a specific unit of plant science. The definitions have reference to fungi (and lichens) and include technical terms with their derivations, vernacular, popular and obsolete (so indicated) terms, and the terms used in the field of medical mycology and antibiotics. The names of the scientists who originated the terms and the date of origin are included with many of the definitions. Numerous references are made to specific plants to which terms are applicable. The inclusion of both the singular and plural endings of the Latin and Greek nouns is very helpful.

The authors have specified with the color terms the color equivalents in Ridgway's *Color Standards and Nomenclature*, and the terms in Maerz and Paul's *Dictionary of Color*, the *Répertoire de Couleurs*, and Saccardo's *Chromotaxia*. The excellent line drawings which illustrate many of the terms are especially helpful. A few minor errors have been noted, such as the substitution of 14 for fig. 16 in plate 7 and the use of the word bactrriform out of alphabetical sequence presumably for bacteriform, the word which follows it in the definition.

The authors are to be congratulated upon the wealth of information contained in the *Glossary of Mycology*, and the book is highly recommended in every respect.—Winona H. Welch.

RECENT LITERATURE ON HEPATICS

Margaret Fulford[1]

Allorge, Valia. Catalogue préliminaire des muscinées du Pays basque français et espagnol. Rev. Bryol. et Lichén. 24(1/2): 96-131. 1955. [148 spp. of hepatics]

——— & Suzanne Jovet-Ast. *Targionia Lorbeeriana* K. M. dans la Pénin-

[1] Dept. of Botany, University of Cincinnati, Cincinnati 21, Ohio.

sule ibérique, aux Açores et aux Canaries. Rev. Bryol. et Lichén. 25 (1/2) : 134-135. 1 *map*. 1956.

ANONYMOUS. Verzeichnis der Schriften von Theodor Herzog. Feddes Repert. 58 : 12-19. 1955.

ARNELL, S. Hepaticae collected in Cuba and Hispaniola by E. L. Ekman. THE BRYOLOGIST 59(4) : 271-276. 6 *fig*. 1956. [New: *Plagiochila ekmanii* n. sp., *P. marginata* n. sp.]

———. Hepaticae collected by O. Hedberg *et al*. on the East African mountains. Arkiv för Bot. II. 3(16) : 517-562. 23 *fig*. 1956. [117 species; new: *Bazzania pulvinata* (St.) n. c., *Cephalozia cavifolia* n. sp., *Chandonanthus cavallii* (Gola) n.c., *Chiloscyphus muhavurensis* n. sp., *Diplophyllum africanum* n. sp., *Euosmolejeunea ruwenzorensis* n. sp., *Gymnomitrion elgonense* n. sp. and var. *squarrosum* n. v., *Lophozia hedbergii* n. sp., *L. kilimanjarica* n. sp., *L. ruwenzorensis* n. sp., *Marsupella hedbergii* n. sp., *M. subintegra* n. sp., *Mylia hedbergii* n. sp., *M. infuscata* (Mitt.) n. c., *Plagiochila hedbergii* n. sp., *Porella hochneliana* n. c.?, *Scapania hedbergii* n. sp., *Tylimanthus ruwenzorensis* n. sp.]

———. Notes on *Inflatolejeunea Mandoni* (St.) H. Persson (*Lejeunea Macvicari* Pears.). Bot. Notiser 109 : 99-100. 1956.

———. Hepaticae collected by Dr. and Mrs. Carl Skottsberg on Cerro Talinay, Prov. Coquimbo, Chile. 1955. Svensk Bot. Tidskr. 50(2) : 308-312. 3 *fig*. 1956. [29 species; new: *Harpalejeunea talinayi* n. sp., *Inflatolejeunea mandoni* var. *chilensis* n. v., *Plagiochila talinayi* n. sp.]

BISCHLER, HÉLÈNE. Revision des espèces suisse de *Calypogeja*. Candollea 16 : 9-76. 13 *fig*. 1957. [New: *Calypogeja muelleriana* var. *muelleriana* f. *compacta* (Meyl.) n. f.]

BUCH, H. & R. TUOMIKOSKI Contribution to the hepatic flora of Newfoundland. Arch. Soc. Zool. Bot. Vanamo 9(Suppl.) : 1-29. 4 *maps*. 1955.

CHADEFAUD, M. Sur l'appareil plastidial d'un *Anthoceros*. Bull. Soc. Bot. France 103(5-6) : 240-247. 6 *fig*. 1956.

CHEN, P. C. Bryophyta nova sinica [Hepaticae]. Feddes Repert. (Festschrift f. Theodor Herzog) 58 : 36-52. 20 *fig*. 1955. [New: *Metzgeria sinensis* n. sp., *Delavayella serrata* var. *purpurea* n. v., *Radula yunnanensis* n. sp., *Madotheca paraphyllina* n. sp., *Drepanolejeunea szechuanica* n. sp., *Leptolejeunea revoluta* n. sp., *Raphidolejeunea yunnanensis* n. sp. *R. foliicola* (Horik.) n. c., *Microlejeunea szechuanensis* n. sp., *Jubula jaoii* n. sp., *Leptocolea ceratilobula* n. sp., *Physocolea gemmifera* n. sp., *P. hainanica* n. sp.]

CLARK, LOIS. *Frullania brachycarpa*. THE BRYOLOGIST 59(2) : 140-143. 19 *fig*. 1956.

———. *Frullania aculeata*. *Ibid*. 59(3) : 218-221. 17 *fig*. 1956.

———. *Frullania gibbosa*. *Ibid*. 59(4) : 280-283. 19 *fig*. 1956.

——— & RUTH SVIHLA. *Frullania arecae*, a variable species. *Ibid*. 59(1) : 36-38. 24 *fig*. 1956.

DIX, W. L. Lichens and hepatics of the Ungava Peninsula [Quebec and Labrador]. THE BRYOLOGIST 59(1) : 43-50. 1956. [10 hepatics]

DUDA, J. Die Lebermoose der mährisch-schlesischen Beskiden. Prirodovedechy Sborn. Oestrawského Kraje 16 : 234-242. 1955. [90 spp.; Russian with German summary]

FULFORD, MARGARET. The pattern of regeneration in *Frullania asagrayana*. THE BRYOLOGIST 59(4) : 265-270. 23 *fig*. 1956.

GOODMAN, G. T. Sexual *Lunularia cruciata* (L.) Dum. in South Wales. Trans. British Bryol. Soc. 3(1): 98-102. 1 *fig.* 1956.

HALBSGUTH, W. Über die Entwicklung der Dorsiventralität bei *Marchantia polymorpha* L. Biol. Zentralbl. 72: 52-104. 10 *fig.* 1953.

HARA, M. A review of *Porella* from Shikoku, southern Japan. Research Repts., Kôchi Univ. [Kôchi, Japan] 4(12): 1-27. 7 *fig.* 1956. [15 species; new: *Porella japonica* var. *calcicola* n. v., *P. tosana* f. *spinosa* n. f., *P. vernicosa* ssp. *vernicosa* and ssp. *faurieri* (St.) n. c.]

HATTORI, S. Hepaticae occurring on the serpentine on Mt. Apoi (Hokkaidō). Bot. Mag. [Tokyo] 68(809): 320-323. 1955. [Japanese with English summary]

———. Editor. Hepaticae Japonicae Exsiccatae. Ser. 7. nos. 301-350. 1956. The Hattori Bot. Lab., Obi, 3888, Nichinan-shi. Miyazaki Prefecture, Japan. Jour. Hattori Bot. Lab. 16: 130. 1956.

———. Notes on little known Japanese species of Hepaticae (4). Jour. Jap. Bot. 31(5): 150-153. 1956. [Japanese with English summary]

———. Notulae de Hepaticis japonicis (18). Jour. Jap. Bot. 31(7): 201-204. *Fig.* 67. 1956. [New: *Lophozia* (*Leiocolea*) *igiana* n. sp., *Porella vernicosa* ssp. *faurieri* (St.) n. c.]

———. A note on Japanese *Frullania moniliata*. Jour. Jap. Bot. 31(9): 283-284. 1956. [Japanese with English summary]

HODGSON, E. AMY. New Zealand Hepaticae (Liverworts)—X. A revision of the New Zealand species of the genus *Lepidozia*. Trans. Roy. Soc. New Zealand 83(4): 589-620. *2 fig.* 1956. [33 species; new: *Lepidozia martini* n. sp., *L. remotifolia* n. sp., *L. meridiana* n. sp. with var. *paludicola* n. v.]

INGOLD, C. T. Cinematographic observations on spore and elater discharge in *Lophocolea*. Trans. British Bryol. Soc. 3(1): 121-123. 1 *pl.* 2 *fig.* 1956.

JONES, E. W. *Riccia sorocarpa* Bisch. in a subalpine habitat [Note]. Trans. British Bryol. Soc. 3(1): 124. 1956.

———. African hepatics. XI. The genus *Riccardia* in tropical Africa. Trans. British Bryol. Soc. 3(1): 74-84. *3 fig.* 1956. [6 species; new: *Riccardia longispica* (St.) n. c., *R. holstii* (St.) n. c., *R. limbata* n. c., *R. stephanii* (Besch.) St. ex E. W. Jones n. c., *R. erosa* (St.) n. c.]

JOVET-AST, SUZANNE. Trois hépatiques marocaines. Rev. Bryol. et Lichén. 25(1/2): 128-133. *3 fig.* 1956.

———. *Harpalejeunea Herzogii* S. J.-A. Lejeunéacée nouvelle de la Guadeloupe. Feddes Repert. (Festschrift f. Theodor Herzog) 58: 19-22. 1955.

———. Hépatiques du Liban et de Shypre. Rev. Bryol. et Lichén. 25(1/2): 187. 1956. [9 species]

———. Essai sur la distribution des hépatiques au Maroc. *Ibid.* 25(1/2): 136-158. *22 maps.* 4 *fig.* 4 *tab.* 4 *pl.* 1956. [110 species and varieties]

KAMIMURA, M. Two new species of Lejeuneaceae astipae from Japan. Feddes Repert. (Festschrift f. Theodor Herzog). 58 (1/2): 55-59. *2 fig.* 1955. [New: *Colojeunea kodamae* n. sp., *Taeniolejeunea magnipapillosa* n. sp.]

LADYZHENSKAJA, K. I. De *Fossombronia angulosa* (Dicks.) Raddi in URSS inventa. [Bot. Materialy] Not. Syst. e Sec. Crypt. Inst. Bot. nomine V. L. Komarovii Acad. Sci. URSS 11: 167-176. *3 fig.* 1956. [New: *Fossombronia angulosa* f. *lencoranica* n. f.; in Russian]

——— & S. M. CHUDAIKULOV. De sporarum formatione Ricciocarpi natantis (L.) Corda. *Ibid.* 11: 182-186. *2 fig.* 1956. [In Russian]

——— & V. M. Obuchova. De genere *Riella* Mont. in agris Oryzae sativae in Kazachstantia observationes. *Ibid.* 11: 176-182. 3 *fig.* 1956. [On *Riella paulsenii* Porsild; in Russian]

MARGADANT, W. D. Bryologische nomenclatuurnotities. 2. De datum van het deel "Hepaticae" in Engler & Prantl's "Natürlichen Pflanzenfamilien." Buxbaumia 10(3/4): 49-50. 1956.

MEIJER, W. A new species of *Exormotheca* from Ceylon. Jour. Hattori Bot. Lab. 16: 72-74. *Fig. A-L.* 1956. [New: *Exormotheca ceylonensis* n. sp.]

MILLER, H. A. Bryophytes collected by F. R. Fosberg in the Marshall Islands. Atoll Research Bull. [Pacific Sci. Board. Nat. Acad. Sci. Washington, D. C.] 40: 1-3. *map.* 1955. [5 mosses, 4 hepatics]

PROSKAUER, J. On a collection of liverworts from Israel. Palestine Jour. Bot. 6(2): 123-124. 1953.

REIMERS, H. Zweiter Nachtrag zur Moosflora des südlichen Harzvorlandes I. Feddes Repert. 58: 145-156. 1955. [33 Hepaticae, 1 *Sphagnum*]

ROBERTSON, JOYCE. Hepaticae—Liverworts. *Pp.* 184-188 *in* G. B. Walsh & F. C. Rimington (editors), The Natural History of the Scarborough District I.—Geology and Botany. xii + 296 *pp.* Scarborough Field Naturalists' Soc. 1953.

ROSE, F. & T. D. V. SWINSCOW. *Southbya nigrella* (DeNot.) Spruce in fruit. [Note] Trans. British Bryol. Soc. 3(1): 124-125. 1956.

SCHUSTER, R. M. North American Lejeuneaceae. I. Introduction, keys to subfamilies and genera. II. Paradoxae: the genera *Aphanolejeunea* and *Leptocolea.* Jour. Elisha Mitchell Sci. Soc. 71(1): 106-148. 5 *fig.* 1955. [New: *Aphanolejeunea ephemeroides* n. sp., *A. evansii* n. sp.]

———. North American Lejeuneaceae. III. Paradoxae: *Cololejeunea,* sectio Minutissimae. *Ibid.* 71(2): 218-247. 5 *fig.* 1955. [New: *Cololejeunea,* sect. Minutissimae n. sec., *C. minutissima* ssp. *myriocarpa* (N. & M.) n. c.]

———. North American Lejeuneaceae. IV. Paradoxae: *Cololejeunea* (concl.), *Diplasiolejeunea. Ibid.* 72(1): 87-125. 8 *fig.* 1956. [New: *Cololejeunea* sect. Calcareae n. sect., sect. Diaphanae n. sect., *C. diaphana* var. *cristulata* n. v.]

———. Review: K. Müller, Die Lebermoose Europas. *In* Rabenhorst's Kryptogamen-Flora VI. Ergänzungsband *pp.* 1-320. 1939-1940; VI. Ed. 3, 1-5: i-xii, 1-756. 247 *figs.* 1951-1954. THE BRYOLOGIST 59(1): 51-56. 1956.

———. Notes on Nearctic Hepaticae X. A study of *Cephaloziella rhizantha, C. floridae* and *C. ludoviciana.* THE BRYOLOGIST 59(2): 130-140. 2 *fig.* 1956. [New: *Cephaloziella rhizantha* (Mont.) n. c.]

———. Review: C. Vanden Berghen, Flore Générale de Belgique, Bryophytes. I. Fasc. 1. i-iv + 131 *pp. Fig.* 1-40. Jard. Bot. de l'État. Bruxelles. 1955. THE BRYOLOGIST 59(3): 230. 1956.

———. Review: T. Amakawa & S. Hattori, A revision of the Japanese species of Scapaniaceae. Jour. Hattori Bot. Lab. 9: 45-62 (1953); 12: 91-112 (1954); 14: 71-90 (1955). *fig.* 1-20. THE BRYOLOGIST 59(3): 230-231. 1956.

———. Review: S. Hattori, Oil bodies of Japanese Hepaticae I-II. Jour. Hattori Bot. Lab. 5: 69-97. *pl.* 1-5. (1951); 10: 63-78. *pl.* 1-3. (1953). THE BRYOLOGIST 59(3): 231. 1956.

———. Review: D. Shimizu & S. Hattori, Marchantiales of Japan. I-IV.

Jour. Hattori Bot. Lab. 9: 32-44 (1953): 10: 49-55 (1953); 14: 91-107 (1955): 23 *fig.* THE BRYOLOGIST 59(3): 232. 1956.

———. *Aphanolejeunea cornutissima* nom. nov. THE BRYOLOGIST 59(3): 217-218. 1956.

SVIHLA, RUTH D. The Frullaniaceae of Burma. I. THE BRYOLOGIST 59(4): 277-280. 9 *fig.* 1956.

THOMPSON, J. S. Possible *Scapania paludosa* in Co. Kerry. Irish Nat. Jour. 11(1): 21. 1953.

VAJDA, VON LASZLO. *Frullania inflata* Gottsche in Ungarn. Rev. Bryol. et Lichén. 25(1/2): 164-166. 1 *fig.* 1956.

RECENT LITERATURE ON LICHENS—22[1]

WILLIAM L. CULBERSON[2]

AHLNER, S. Värmlands märkligaste lav. Nat. i Värmland 1954: 99-102. 2 *fig.* 1954. [*Erioderma boreale.*]

ALMBORN, O. Lichenes Africani. Fasc. I. (Nos. 1-25). 8 *pp.* Lund. 1956. [Labels for Nos. 1-25 in this exsiccata. New: *Xanthoria flammea* f. *thallophora* (Hillm.) n. c.]

ASAHINA, Y. Lichenologische Notizen (§ 120). A new arrangement of Japanese *Cladonia verticillata*-group. Jour. Jap. Bot. 31(11): 322-325. 1956. [New: *C. krempelhuberi* v. *subevoluta* (Asahina) n. c., v. *subsobolifera* (Asahina) n. c., v. *sublepidota* (Asahina) n. c.; *C. calycantha* v. *gracilior* n. v. and f. *recurvans* n. f.]

BOULY DE LESDAIN, M. Formes et variétés du *Ramalina farinacea* (L.) Ach., et notes sur les *Ramalina intermedia* Nyl. et *pollinaria* Ach., avec lesquelles il a été souvent confondu. Rev. Bryol. et Lichén. 25(3-4): 308-316. (1956) 1957. [New: *R. farinacea* v. *minutula* f. *evoluta* n. f., f. *ulcerata* n. f. (*nomina nuda*).]

BUSTINZA, F. Antibiotics from lichens. *Pp.* 57-67 *in* 8ème Congr. Internatl. Bot., Rapp. & Comm. Sect. 21. 1954. [Review with a 44-reference bibliography.]

CHOISY, M. A propos de la taxinomie des champignons des lichens. Rev. Bryol. et Lichén. 25(3-4): 317-320. (1956) 1957. [Comments on a recent controversy.]

DODGE, C. W. The Machris Brazilian Expedition. Botany: The Lichens. Los Angeles County Mus., Contrib. in Sci. 1957(4): 1-2. 1957. [14 taxa. New: *Pseudocyphellaria clathrata* (DNtrs.) n. c.]

DOIGNON, P. Les groupements végétaux du Massif de Fontainebleau. Cahiers des Nat., Bull. des Nat. Parisiens n. sér. 12: 3-16, 33-40. 1956. [Some lichens, many bryophytes.]

DUGHI, R. Appareils apicaux des asques et taxinomie des *Collema*. Compt. Rend. Acad. Sci. [Paris] 243: 1911-1913. 5 *fig.* 1956.

———. La signification des appareils apicaux des asques de *Gymnophysma* et de *Chlamydophysma*. *Ibid.* 243: 750-752. 1956.

ERDTMAN, H. & C. A. WACHTMEISTER. The structure of porphyrilic acid. Chem. & Indus. [London] 1956: 960. 1956. [From *Haematomma coccineum.*]

---

[1] The names of new taxa from the Americas bear an asterisk (*).

[2] Dept. of Botany, Duke University, Durham, N. C.

——— & ———. Phenoldehydrogenation as a biosynthetic reaction. *Pp.* 144-165 *in* Sandoz, Ag. [Sandoz Ltd., Basel]: "Festschrift Arthur Stoll." Basel. 1957. [Many lichen substances.]

FAEGRI, K. Johan Havaas. Univ. i Bergen, Årsmelding 1955-56: 22-24. 1 *portrait.* 1956. [Necrology.]

FAGERSTRÖM, L. Lavar från norra Veckelaks (Vehkalahti) i Karelia australis. Mem. Soc. Fauna et Flora Fenn. 29: 45-50. (1952-1953) 1954. [Lengthy notes on *Parmelia cetrarioides* v. *rubescens* (T. Fr.) DR., *Opisteria arctica* (L.) Vain., *Nephroma lusitanicum* Nyl., *Leptogium cyanescens* (Ach.) Kbr.]

———. Nya fynd av *Calicium deminuens* Vain. *Ibid.* 29: 50-51. (1952-1953) 1954. [New Finnish stations.]

———. *Umbilicaria pustulata* funnen i Humppila (sydvästra Tavastland). *Ibid.* 29: 50. (1952-1953) 1954.

GALINOU, MARIE-AGNES. Recherches sur la flore et le végétation de lichens épiphytes, en forêt de Mayenne. Bull. Soc. Sci. Bretagne 30: 17-43. 1 *fig.* 1955. [Many spp. and phytosociologic data.]

———. Sur la structure de l'appareil apical des asques chez les Pyrénolichens des genres *Laurera* et *Trypethelium.* Compt. Rend. Acad. Sci. [Paris] 243: 1146-1149. 1956.

GILLHAM, MARY E. Ecology of the Pembrokeshire Islands. III. The effect of grazing on the vegetation. Jour. Ecol. 43(1): 172-206. 6 *fig.* 4 *tab.* 1955. ["Bryophytes, which form an important part of the turf where [rabbit] grazing is heavy in inland areas, are of little importance on sea cliffs as they cannot withstand exposure to wind and salt. Their place is taken by minute rosette angiosperms or lichens . . ."—Author's Summary.]

HAKULINEN, R. Veili Räsänen. 24. VIII. 1888—16. VII. 1953. Kuopion Luonnon Ystäväin Yhdistyksen Julkaisuja, Sarja B 3(2): 1-32. 1 *portrait.* 1956. [Necrological essay and bibliography of Räsänen's publications.]

HALE, M. E. Lecture Notes. Lichenology. *73 pp. Illus.* West Virginia University. Morgantown. 1957. [A digest—as notes from a course taught by Dr. Hale—of recent concepts, study methods and findings in lichenology.]

———. Lichenes Americani Exsiccati. Fascicle III (No. 51-75). 4 *pp.* Morgantown. 1957. [Labels for specimens.]

———. The *Lobaria amplissima-L. quercizans* complex in Europe and North America. THE BRYOLOGIST 60(1): 35-39. 1 *fig.* 1957.

IMSHAUG, H. A. Catalogue of Mexican lichens. Rev. Bryol. et Lichén. 25(3-4): 321-385. (1956) 1957. [A compilation of many taxa.]

KORTEKANGAS, A. E. Usnic acid derivative of 4-amino-3-isoxazolidone (Cycloserine). Suomen Kemistilehti B 29: 30-31. 1 *tab.* 1956. [Activity of the substance against 8 microörganisms.]

——— & O. E. VIRTANEN. The antibiotic activity of some amino compound derivatives of usnic acid III. *Ibid.* 29: 2-4. 3 *tab.* 1956. [Tuberculostatic activity of the impure amino compound derivatives.]

KUROKAWA, S. Notulae miscellaneae Lichenum japonicorum (3). Jour. Jap. Bot. 31(11): 351-352. 1 *fig.* 1956. [*Actinogyra mühlenbergii* (Ach.) Schol. from Japan.]

LAMB, I. M. *Compsocladium,* a new genus of lichenized Ascomycetes. Lloydia 19(3): 157-162. 6 *fig.* 1956. [*Compsocladium* n. gen. (Lecideaceae), *C. archboldianum* n. sp.]

MATTSON, SANTE & ELISABETH KOULTER-ANDERSSON. The acid-base condi-

tion in vegetation, litter, and humus. XI. Acid and base in decomposing litter. Kungl. Lantbruckshögskolans Ann. [Uppsala] 21: 389-400. 6 *fig.* 3 *tab.* 1954. [Including periodic determinations over 14 years of the *p*H and the base content of a decomposing litter of *Cetraria islandica*.]

PAATSAMA, S. & S. TALANTI. Otitis-terapiasta koirilla. [On Otitis therapy in the dog.] Suomen Eläinlääkärilehdestä 1956(12): 8 *pp.* 3 *tab.* 1956. [Use of the usnic acid preparation "Usno."]

PEARSALL, W. H. Mountains and Moorlands. xv + 312 *pp.* 50 *fig.* 64 *pl. with 32 in color.* 14 *tab.* Collins. London. 1950. [Lichens, pp. 82, 144, 145, 149. Numerous bryophytes.]

PRESTHEGGE, K. Forsøk med lav til drøvtyggere og svin. [Experiments with lichen for ruminants and swine.] Forskning og Forsøk i Landbruket [Oslo] 5(6): 437-523. 8 *diagrams.* 2 *pl.* 13 *tab.* 1954. ["With the feed value found in the group experiments—a feed value which is also substantiated by the digestibility experiments—lichen will in many cases constitute a rather inexpensive fodder for ruminants."—English Summary.]

RUDOLPH, E. D. Revisionary studies in the lichen family Blasteniaceae in North America north of Mexico. Diss. Abst. 15(8): 1300-1301. 1955. [Abstract.]

RUNEMARK, H. Studies in *Rhizocarpon*. I. Taxonomy of the yellow species in Europe. Opera Bot., a Soc. Bot. Lundensi in Supp. Ser. "Bot. Not." Edita 2(1): 1-152. 39 *fig.* 6 *tab.* 1956. [29 spp. Keys. New: *R. superficiale* ssp. *splendidum* (Malme) n. c., ssp. *boreale** n. ssp.; *R. dispersum* n. sp.; *R. pusillum* n. sp.; *R. parvum** n. sp.; *R. subtile* n. sp.; *R. tetrasporum* n. sp.; *R. cookeanum** H. Magn. n. sp.; R. *lindsayanum* ssp. *kittilense* (Räs.) n. c.; *R. tinei* (Tornab.) n. c. with ssp. *diabasicum* (Räs.) n. c., ssp. *prospectans* (Räs.) n. c., ssp. *vulgare** n. ssp., ssp. *frigidum* (Räs.) n. c., ssp. *arcticum** n. ssp.; *R. atroflavescens* ssp. *pulverulentum* (Schaer.) n. c.; *R. carpaticum* n. sp.; *R. sorediosum* n. sp.]

———. Studies in *Rhizocarpon*. II. Distribution and ecology of the yellow species in Europe. *Ibid.* 2(2): 1-150. 47 *maps.* 2 *tab.* 1956. [Including maps with the North American distribution of *R. parvum* Runemark, *R. inarense* (Vain.) Vain., *R. atroalbescens* (Nyl.) Zahl., *R. ferax* H. Magn., *R. tinei* ssp. *arcticum* Runemark.]

RYDZAK, J. A method of studying growth in lichens. Ann. Univ. Mariae Curie-Skłodowska Sect. C. [Lublin] 10(4): 87-91. 1 *fig.* 1956.

———. Wpływ małych miast na florę porostów. Część III. Tatry. Zakopane. [The influence of small towns on lichen vegetation. Part III. The Tatra. Zakopane.] *Ibid.* 10(7): 157-175. 1 *map.* 1 *tab.* 1957. [58 taxa. English summary.]

SCHADE, A. Schneckenfrass an Flechten. Decheniana 108(2): 243-245. 2 *fig.* 1956.

———. Arten der Flechtengattung *Umbilicaria* als Pollenfalle. *Ibid.* 109(1): 83-86. 1956. [11 spp.]

SPECTOR, W. S. (editor). Handbook of Biological Data. xxxvi + 584 pp. WADC Tech. Rept. 56-273. ASTIA Document No. AD 110501. Wright Air Development Center, Air Res. & Development Command, U. S. Air Force, Wright-Patterson Air Force Base, Ohio. 1956. [Respiration of lichens and bryophytes, p. 263; heat and cold resistance of lichens and mosses, pp. 448-449; permeability of cell surfaces of mosses to non-electrolytes, pp. 46-47.]

TOBOLEWSKI, S. Zielnik Porostów Polski. Fasc. VII. Nr. 126-150. Porosty

Tatr. [Lichenotheca Polonica. Fasc. VII. Nr. 126-150. Lichenes Tatrenses.] 9 pp. 1 *map*. (Acad. Sci. Polon.) Poznań. 1955. [Labels for nos. 126-150 in this exsiccata.]

Vězda, A. Lichenes Bohemoslovakiae Exsiccati, Editi ab Instituto Botanico Universitatis Agriculturae et Silviculturae, Brno, ČSR. Fasciculus I. Dec. 1-3 (1957). 8 *pp*. Brno. 1957. [Labels for nos. 1-30 in this exsiccata.]

———. Soupis lichenolgické literatury, pojednávající o výskytu a rozšíření lišejníků na území ČSR. Zusammenfassung der lichenologischen Literatur über das Vorkommen und die Verbreitung der Flechten im Gebiete der Tschechoslovakischen Republik. Časopis Slezského Mus.—Acta Mus. Silesiae, ser. A 5: 90-117. 1956. [About 500 references.]

Virtanen, O. E. The antibiotic activity of some amino compound derivatives of 1-usnic acid II. Suomen Kemistilehti B *27*: 67-70. *3 tab*. 1954. [Tests with 7 microörganisms.]

———. Usniinihapon ja sen johdannaisten käyttömahdollisuuksista eläinlääkinnässä. [On the possibilities of using usnic acid and its derivatives in veterinary medicine.] Suomen Eläinlääkärikehdestä 1956(5): 8 *pp*. 1 *fig*. 1956.

———. Derivatives of usnic acid with the most important tuberculostatic agents. Suomen Kemistilehti B *28*: 125-126. 1955.

———. On the toxicity of an usnic acid preparation with the trade name Usno. *Ibid*. *29*: 225-226. 1956.

——— & O. E. Kilpiö. On the *in vivo* fungistatic activity of an usnic acid preparation with the trade name Usno. *Ibid*. 30: 8-9. *2 fig*. 1957.

Werner, R. G. Elément bryologique et lichénologique dit "océanique" en Tunisie. Congr. Assoc. Franç. Avanc. Sci. [Tunis] 70(IV): 3 *pp*. 1951. [20 lichens.]

———. Contribution à la flore cryptogamique du Maroc.—XIX. Bull. Soc. Sci. Nat. & Phys. du Maroc 35: 19-67. 5 *fig*. 1955. [176 spp. and a key. New: *Verrucaria gattefossei* n. sp.; *V. subacrotella* n. sp.; *Polyblastiopsis* (*?*) *maroccana* n. sp.; *Bacidia* (Bilimbia) *pasqualinii* n. sp.; *Cladonia rangiformis* f. *spissa* n. f.; *Ramalina calicaris* ssp. *fallaciosa* Choisy *in litt*.) n. c.; *R. duriaei* f. *diversa* n. f., f. *tuberculata* n. f., f. *fistulosa* n. f.; *R. macroformis* f. *monophylla* n. f., f. *laciniata* n. f., f. *taeniaeformis* n. f.; *R. ramulicola* f. *monophylla* n. f., f. *dilacerata* n. f.; *Caloplaca flavovirescens* v. *miniata* n. v.; *Buellia gattefossei* n. sp.]

———. Contribution à la flore cryptogamique du Maroc. Fascicule XX: Lichens de l'Anti-Atlas. Bull. Soc. Hist. Nat. Afrique du Nord 47: 84-91. 1956. [43 taxa. New: *Pyrenopsis subolivacea* n. sp., *Heppia subgucpini* n. sp., *Buellia subcanescens* n. sp.]

———. Etude sur la migration de quelques lichens. Bull. Soc. Sci. Nancy 1955: 12 *pp*. 1 *map*. 1955. [Notes on *Parmelia saxatilis*, *Evernia prunastri* and several spp. of *Umbilicaria*; comments on their American distribution.]

———. Nouvelles recherches sur les ascospores des lichens et leur germination. *Ibid*. 1956: 15 *pp*. 17 *fig*. 1956. [Spores of *Verrucaria* and of *Pertusaria*.]

———. Notes de lichénologie libano-syrienne. III. Bull. Soc. Bot. France 103(7-8): 461-467. 1956. [43 taxa. New: *Lecanora* (Aspicilia) *auricularis* n. sp., L. (A.) *dubertretii* n. sp., *L.* (A.) *farinosa* f. *subopegraphoides* n. f., *L.* (A.) *subcaesiocinerea* n. sp., *Caloplaca* (Gasparrinia) *farinulenta* n. sp.]

NEWS AND NOTES

The Société Botanique de France recently awarded the 1956 Coincy Prize to ALPHONSE LACHMANN, professor at the agricultural institute at Yzeure for his outstanding botanical researches which include much work on bryophytes.

In May ANNETTA CARTER of the University of California at Berkeley left for Ann Arbor where she will spend six months organizing the incorporation of the Harley H. Bartlett Herbarium into the herbarium of the University of Michigan.

RUDOLPH M. SCHUSTER has accepted a teaching position at the University of Massachusetts at Amherst.

During the past semester HANSFORD T. SHACKLETTE has been teaching at Hanover College in Indiana as a substitute for James Maysilles, who has been absent on leave to complete his studies for a Ph.D. at the University of Michigan.

MASON E. HALE, JR. has accepted a position at the Smithsonian Institution as curator of cryptogams beginning June 15.

MAURICE BIZOT has been named director of the École de Médecin et de Pharmacie de Dijon.

The editor of *The Bryologist* has been informed that funds have been granted by the National Science Foundation to aid in the publication of the index to volumes 1-60. The index will accordingly be published as nearly after the completion of volume 60 as possible. Only the current volume remains to be done and the manuscript to be typed.

H. L. BLOMQUIST will retire this spring as professor of botany at Duke University. He will be succeeded by Robert L. Wilbur, one of his former students now at North Carolina State College.

Parts 6, 7 and 8 of Müller's very important *Die Lebermoose Europas* (ed. 3) were recently published, as a continuation of volume 6 of Rabenhorst's *Kryptogamenflora*. Dr. Theodor Herzog is to be thanked for his excellent job of editing. These three fascicles include pp. 757-1220.

WINONA H. WELCH has written that her *Mosses of Indiana* will appear in print in 1957; she has returned the corrected page proofs complete with running heads, contents and index. The book will be illustrated and will run to 478 pages in length.

The annual meeting of the American Bryological Society will be held in conjunction with the A. I. B. S. meetings at Stanford University, California, on August 26. The foray preceding it on August 23-25 will be led by William C. Steere, Albert W. Herre and Herman Persson. Interesting localities within 35 miles of the campus to be visited include Fatjo Ranch, Devil's Canyon, Alum Rock Park, Castle Rock, Big Basin State Park, Pilarcitas Creek Canyon and Searsville Lake, and the habitats include coast redwoods, sea coast, very old walnut groves, fog-swept ridge oaks and Douglas fir forests. Transportation will be by private automobiles. For particulars on accommodations, etc., write John W. Thomson (University of Wisconsin).

RUDOLF M. SCHUSTER plans to spend the summer at the Highlands Biological Station in North Carolina,

and LEWIS ANDERSON will also spend part of the summer there.

T. G. YUNCKER will spend the next school year collecting mosses and other plants in Jamaica. He will hold a Fulbright fellowship and will be associated with the University College of the British West Indies.

DR. P. KACHROO, who has spent the past year at the University of Michigan, working on the Lejeuneaceae, will leave for his home in India June 12.

Volume 60, Number 1 (pp. 1-65) was issued March 30, 1957.

AVAILABLE NOW

ALL BACK NUMBERS

OF

THE BRYOLOGIST

(Some numbers reprinted by photo offset)

COMPLETE SETS

Broken sets Individual Numbers

Price List

Volumes 1-4—$1.25 per volume
(single numbers, 35c)

Volumes 5-36—$2.50 per volume
(single numbers, 60c)

Volume 37—$3.00 per volume
(single numbers, 65c)

Volumes 38-45—$3.50 per volume
(single numbers, 85c)

Volumes 46-49—$4.00 per volume
(single numbers, $1.25)

Volume 50—$8.00 per volume
(single numbers, $2.50)

Later Volumes—$5.00 per volume
(single numbers, $1.50)

All prices net. No discounts. Postage extra.

Order from

Lewis E. Anderson
Department of Botany,
Duke University,
Durham, North Carolina.

THE STUDENT'S HANDBOOK OF BRITISH MOSSES (THIRD EDITION)

by H. N. Dixon

With illustrations by H. G. Jameson

Third edition (1924), pp. xlviii + 582, with 63 plates, 8vo cloth. This well-known standard work has been out of print for some years, and we have now arranged for a reprint which should be ready early in 1953. Orders will now be accepted and payment can be made by International Money Order obtainable at any Post Office. $7.25 post free.

Wheldon & Wesley Ltd.

83/84, Berwick Street, London, W. 1, England

A MANUAL OF THE MOSSES OF WESTERN PENNSYLVANIA AND ADJACENT REGIONS (SECOND EDITION)

by O. E. Jennings

A fully illustrated manual with descriptions and keys for the identification of 286 species of mosses. 396 pages, 72 plates. Bound in cloth, $4.25.

UNIVERSITY OF NOTRE DAME PRESS

Notre Dame, Indiana

THE HEPATIC EXCHANGE

Beginning January 1, 1939, this Exchange has been operated under the same rules as The Moss Exchange. Privileges are available only to members of the American Bryological Society who have paid annual dues of 25c to Dr. Leo F. Koch, Herbarium, 350 Natural Science Bldg., University of Illinois, Urbana, Ill. Only fully determined specimens in packets with complete data will be accepted. It is suggested that there be at least five packets of each species with an extra which will be forwarded to the Curator of Hepatics for the American Bryological Society Hepatic Herbarium. All material for determination should be sent to the Curator of Hepatics, Dr. Margaret Fulford, Department of Botany, University of Cincinnati, Cincinnati, Ohio.

THE MOSS EXCHANGE

As announced in The Bryologist **38**: 100, Sept.-Oct., 1935, there is now an exchange for mosses. This exchange is available to members of the American Bryological Society upon payment of annual dues of 25c to Dr. E. H. Ketchledge, Dept of Forest Botany, State College of Forestry, Syracuse 10, New York. Only fully identified specimens in packets with complete data on them should be sent in. It is suggested that there be five or more packets of each species.

These two exchanges offer an excellent opportunity for A.B.S. members to build up their own herbaria of choice, well-labelled specimens.